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AND

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THE FOUNDRY TRADE JOURNAL,
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BRITISH FOUNDRYMEN'S ASSOCIATION.

LIST OF SECRETARIES.

General Secretary: J. E. H. Allbut, Reservoir House, Butterley, Derby.

Manchester: Edward Oakes, 46, Ashfield Road, Dickenson Road, Rusholme, Manchester.

Birmingham: C. Heggie, 76, Hillaries Road, Erdington, near Birmingham.

Cardiff: R. Griffiths, Messrs. J. Williams & Sons, Ltd., Globe Foundry, Cardiff.

NOTES AND COMMENTS.

Iron Castings from Metallic Moulds.

The possibility of successfully casting iron in metallic moulds has of late come rather prominently before the foundry trade, and a paper read by Mr. E. A. Custer before the Franklin Institute, Philadelphia, may be taken as a valuable contribution on the subject. Since the presentation of the subject by Mr. J. H. Shaw before the American Foundrymen's Association in 1907, an account of which we published at the time, demonstrations in London of the Szekely process have drawn still greater attention to the subject.

Machine moulding has greatly reduced the cost of producing duplicate castings made in large numbers, and multiple moulds have been effectively employed for small castings. But what has already been accomplished with indestructible iron moulds that will produce machinable castings, has directed attention to the great possibilities of this line of development. The data presented in Mr. Custer's paper show that the question of heat treatment is of commanding importance, given an iron comparatively high in carbon and of moderate silicon content. In the making of cast-iron pipes for sanitary uses, the particular line of manufacture for which the process was developed at Tacony, Pa., the noteworthy features are the rapidity with which the molten iron is introduced into the mould, the short time within which it sets, and the speedy removal of the casting from the chilling influence of the iron mould. In the case of the Szekely process it was claimed that no special mixture was necessary, and that with ordinary foundry iron the resultant casting would be better than could be obtained from sand moulds with the same iron. In this process, also, the speedy opening of the mould almost directly after casting is a prominent feature. Under both processes the absence of shrinkage is noteworthy.

Hitherto, castings of a substantial nature, such as car couplers and brake shoes, have been the class of work to which metallic moulds have been applied, but Mr. Custer's paper indicates the possibility of success with thin sections. From certain of the Szekely demonstrations it would appear that that process could be adapted to thin work also, for one example—a double motor cylinder—showed excellent results on the thin parts. It would appear that both this process and the one described by Mr. Custer are being worked on practically the same basis, though Szekely claims that an essential feature of his process is the coating of the mould with his solution.

Contraction of Cast Iron.

Of all the problems that the foundryman has to face there are probably none less amenable to control and regulation than is the problem dealt with by Mr. Fraser in his paper "Notes on Contraction," which we publish in this issue. Every founder is constantly having to cope with the question of unequal contraction, but the seemingly erratic conduct of metal during the process of cooling produces so many phases of the trouble, that it is often regarded as hopeless to attempt to apply any law or rule to the subject. Writers on foundry topics have always been more or less shy of giving an explanation of the twisting and bending of castings, and the trouble of brittleness and undue liability to breakage. There is, of course, a definite law underlying all the trouble, but as Mr. Fraser explains, the effect of that law varies with almost every slight variation of the local conditions; hence the difficulty in applying any defined rule for the amelioration of the trouble.

Internal stresses can be greatly reduced, if not overcome, by efficient annealing, but this entails an expense which is not always justifiable. Accordingly, the founder is forced to seek for some other solution, and as every casting has to be treated according to its own conditions the matter demands perpetual attention and experiment. It would appear, then, that experience is the surest aid to success, and that the maintenance of regular conditions is of the utmost importance.

Mr. Fraser can scarcely be said to offer a solution to the problem, but his researches, and the information he gives, lead to the conclusion that so long as iron is cast into moulds of a resilient nature, such as sand moulds, the liability to twist, bend, and fracture will exist and often become unpleasantly apparent. To combat the difficulty it is necessary to apply intelligently the laws of contraction to the existing conditions, keeping those conditions as regular as possible. Whether the application of a remedy will ever be reduced to a mathematical formula it is impossible to say; at present we can only welcome any information on the subject that experience and research supplies, and apply it to the best advantage.

The Foundry Book Shelf.

Mindful that the true province of a technical journal is the education and assistance of its readers, we are inaugurating in this issue a scheme which we trust will prove both welcome and helpful.

Many foundrymen will doubtless have experienced some difficulty in learning just what books are most suitable for some special course of study; for the branches of foundry work are many, and while the literature at the disposal of the student can scarcely be termed prolific, without some guidance it is difficult to light on the works best suited to the individual.

It is to meet this want that we propose to place before our readers each month some book, or books, likely to be acceptable to some branch of the trade. The treatment will necessarily be brief, but we will endeavour to show what ground is covered by the authors and the nature and extent of the subjects dealt with. It is hoped by this means to obviate any experimental purchasing on the part of students, and if the attention of even only a few is directed into the right channels the departure will be justified.

Specialisation in the Foundry.

From the earliest time in the history of trade, it became evident that men, in order to acquire that proficiency which is necessary to make work of any value, must resort to the specialising of their professions. In the same way, when these trades developed, it was found that by dividing them into sections, the output could be very much accelerated, and the work produced with a greater degree of economy, than when it was carried through its various stages by the same workmen.

The foundry trade is specialised in the first instance under two distinct heads, viz.:—Engineering and General.

These, in their turn, are divided into a considerable number of sections, each of which forms within itself an important industry.

We do not know any branch of trade where special knowledge may be used to

such advantage as in the foundry. There are few foundries now where some branch of the industry is not specialised. But still there is a want of concentration in many of our works which might profitably be remedied.

This may be attributed in some degree to the fact that in this country we lack facilities for acquiring special training in foundry work, which exist in other countries. We see certain indications, however, that specialised training is having the attention of our educationists; this, in our opinion, is a step in the right direction, and good results should follow.

To the researches of the specialist the community at large are indebted for much. The extensive knowledge which he has acquired has not remained with him; it has been acquired for the community at large, and but for the energies of those specialistic workers, information of which we are now the happy possessors, would never have reached us.

Specialisation: Its Advantages.

The chief advantage to be gained from specialisation is, that by catering for a certain class of trade, the founder can arrange his plant to the utmost advantage, the result of which is he can quote prices for his particular class of work which others, who are not in such a favourable position, are unable to touch. Moreover, workmen who are continually engaged at one particular class of work become experts, which means that the work can be turned out with the utmost despatch.

Specialisation: Its Disadvantages.

The system of specialisation, looked at from the workers' point of view is attended by many evils, and for the alleviation of these evils it is difficult to suggest a remedy. When a man is asked to concentrate his energies on one piece of work, he may become an expert, but the tendency is for his experience and his power of observation, other than that on which he is immediately concerned, to become limited.

In this way his work may get monotonous, and any work which does not keep the brain in that exercise which is necessary for the development of its powers is bound to have a somewhat deteriorating effect on the individual.

Certain branches of the trade, although specialised to some degree, give ample scope to the worker for the exercise of original and independent thought, and foundrymen who have the necessary ability will find in these branches of the foundry trade work congenial to their tastes.

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A NEW DEOXIDISER FOR STEEL.

The influence of manganese, silicon, and aluminium in the prevention of blow holes and in the deoxidising of steel is well known and generally admitted. One of the chief causes of the formation of blow holes is due to ferrous-oxide present in the molten metal. It has been found by careful experiments that the deoxidising action of manganese, silicon, and aluminium, is more thorough, and gives more uniform and satisfactory results when these metals are added to the molten steel in the form of a triple alloy of special composition. The same results cannot be obtained by adding these metals singly or in the form of ferro-alloys. Many works attempt the complete deoxidisation of steel by adding proportions of ferro-manganese, ferro-silicon, or manganese silicon alloy, and aluminium. The composition of these alloys varies considerably, and the results obtained are by no means satisfactory.

For many years a silicon, aluminium, and manganese alloy has been manufactured by an English firm—Messrs. Geo. G. Blackwell, Sons & Company, Limited, of Liverpool—and this alloy is being extensively used. The firm, however, for high-grade steels has recently introduced a more powerful combination of silicon, aluminium, and manganese (which has been patented) of the following approximate analysis:—Manganese, 58 per cent.; silicon, 25 per cent.; aluminium, 15 per cent.; iron, 2 per cent.; carbon, 0.20 to 0.30 per cent. It is obvious that such an alloy must be a powerful deoxidiser, and should be very efficient for the prevention of blow holes and flaws. The makers state that this combination alloy can be used in all classes of steel, and will be particularly advantageous for the manufacture of high-grade steel castings. In practice it is found that the addition of 350 to 375 grammes of the alloy is sufficient to completely deoxidise 100 kilograms of open-hearth steel. To do the same work with 80 per cent. ferro-manganese about 1.5 kilogram of ferro manganese would have to be added, and one-third of this, say, about 0.5 kilogram, would nearly all remain undecomposed in the steel in the form of double carbides of iron and manganese.

British Foundrymen's Association.

Fourth Annual Balance-Sheet, 1907.

A Council meeting of this Association was held at the Midland Hotel, Birmingham, on April 11th, when the following balance-sheet for the year 1907, was presented: —

Income.	£	s.	d.
Balance, 1906	22	15	3½
232 Members at 7s. 6d.	87	0	0
18 Honorary ditto at £1 1s. ...	18	18	0
Sale of Books	0	11	3
Total	129	4	6½

Expenditure.	£	s.	d.
Postage	12	15	0
Printing and Stationery	10	19	2
Council Expenses	3	19	6
Audit ditto	3	10	6
Expenses Annual Meeting ...	12	7	6½
Printing Proceedings	30	3	0
Branch Expenses	14	13	11½
Clerical Assistance	2	15	3
Secretaries Expenses	5	5	2
Cash in Secretary's Hands ...	7	10	4
Cash in Bank	25	5	1½
Total	129	4	6½

Audited and found correct, April 11th, 1908.

F. J. COOK,
R. MASON,
F. W. FINCH.

J. E. H. ALLBUT, *Secretary.*

PROMINENT MEN IN THE WORK OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

The success and popularity with which the work of this Association is attended naturally directs attention to those personalities whose energies have been, and still are, doing so much for the foundry trades.

The name of Mr. Robert Buchanan is a very familiar one in foundry circles, to that part at least which interests itself in foundry literature and modern movements in the foundry world. He is president of two associations—the Birmingham Branch of the British Foundrymen's Association and of the South Staffordshire Iron and Steel Institute, a society of 40 years' standing, whose headquarters are at Dudley. He is a member of the Council of the British Foundrymen's Association, in the formation of which he took a leading part; and in recognition of his public work in all these capacities he has been elected a Fellow of the Society of Arts. This latter is a signal and well-merited honour conferred upon one who, practically self-taught, has by his own unaided abilities risen from the lowest rung in the foundry shop.

Mr. Buchanan, in the few moments of leisure which he snatches from the cares of managing the works of Messrs. Chamberlain & Hill, Walsall, is busily preparing papers and lectures. He is in great demand, not only by societies with which he

Mr. Robert Buchanan.

is officially connected, but his breezy, energetic personality is almost as familiar in South Wales, Lancashire, and Yorkshire, as it is in the Midlands. In February last he delivered an address in the historical chamber of the Society of Arts, Adelphi, London, on his favourite subject of the application of science to foundry work.

At the age of fourteen Mr. Buchanan commenced his career as an apprentice in a Dumbarton foundry, now defunct. He served a seven years' apprenticeship, and those years he considers to have been in-

MR. C. HEGGIE,
Hon. Secretary and Treasurer of the Birmingham Branch.

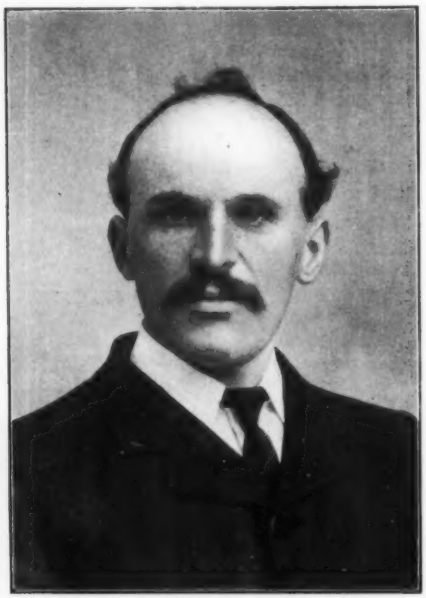
MR. E. B. CRUMP,
Member of Birmingham Branch Council.

valuable. He is a firm upholder of a seven years' term, and in the course of an interesting chat with one of our representatives recently, he declared that "no man is going to be a competent workman who serves less time. The four years' system adopted by the Americans gives us a distinct advantage over them."

"As a matter of fact," Mr. Buchanan continued, "many of the leading workmen in America are of British training, which is good evidence of our system of apprenticeship being a desirable thing. In my early days it was apprenticeship right through the shop, and the seven years' system is not loosing ground in the higher walks of foundry work; but it is to some extent where repeat castings are mainly turned out. No one with any knowledge of foundry work would advocate a lower minimum than seven years. There is no use contrasting engineering with foundry work, and it is only those who have not been through the mill who instance the five years' system in engineering as an argument for a shorter term in the foundry. The policy of the trade unions in this respect is conducive to the maintenance of a high quality of skill.

"I do not believe that we have a better type of men in the shops than we had when I served my apprenticeship. The skill of the average manager and foreman was not then, and is not now, equal to the practical skill of the leading workmen in the foundry. The only way to get hold of this practical skill is to go through the shops. I know one excellent manager who is not a practical foundryman, but he is notable on account of his rarity. The ordinary foundryman has better opportunity now than he ever had of acquiring technical knowledge, but unfortunately the deficient education imparted in the elementary schools, com-

bined with the fact that the foundry does not attract such a high class of lad as engineering does, makes the advance of technical education in the foundry shops very much less rapid than it ought to be. However, while it may be said that the men are not taking the advantage they might do of the technical instruction provided, it is an encouraging fact that a very much larger proportion have been attending these schools than ever before. I have this on the authority of Mr. W. McFarlane, principal of the Wednesbury School.



MR. R. MASON,

Vice-President of Birmingham Branch Council, also Member of Parent Association.

MR. F. J. COOK,

Vice-President of Parent Association, and Member of Birmingham Branch Council.

"The only way a foundryman can get a certificate of his technical ability is by attending these schools, and with regard to the suggestion that the B.F.A. might institute a diploma, I think it would be quite feasible to draft a scheme of examination that would test a man's practical and theoretical ability. I have no doubt it would be very helpful to many a young fellow, especially as employers have great difficulty in picking out men who are in front of their fellows."

Mr. Buchanan himself has always been an ardent student. His recipe of success to a foundryman may, indeed, be summed up as follows:—"Hard work and the love of it, and an insatiable desire to get at the bottom of all the phenomena that arise during the day's operations in a foundry." Mr. Buchanan tells the following story of how he was first induced to try and probe these mysteries. When he was first in charge of a foundry, he cast a heavy hydraulic cylinder, and with others believed that pig-iron was the most suitable material for best work. It was sent out to be machined, and the bottom was pushed out after three days' work. This was particularly disappointing, as the fitter who was dressing the casting had drawn his attention to the beautiful iron it was. When he got back the cylinder, he saw that the fracture presented very large crystalline grains, and he came to the conclusion that there was something in the matter he did not know of.

He began his studies then, and has never ceased them. But for them, he declares, "I should have still have been a '36 bob' man." After managing a small foundry in Dumbarton, he was two years with Messrs. Musshetts, Dalkeith, and then came to Messrs. W. & T. Avery's, Soho Foundry,

Birmingham, where he was the means of having a laboratory established, and where he had ample opportunities of prosecuting his experiments, which he supplemented by attendance at the Technical Schools. Two years ago, still in the prime of life, he left Birmingham to fill the post of joint managing director of the Walsall firm of Chamberlain & Hill.

We reproduce a portrait of Mr. C. Heggie, the Hon. Secretary and Treasurer of the Birmingham Branch of the British Foundrymen's Association. This gentleman's name must be familiar to all who have followed the progress and discussions of the Association, for he has been frequently prominent in the work for the cause of advancement. Amongst other strenuous workers may be mentioned Mr. E. B. Crump and Mr. R. Mason, members of the Branch Council. The latter gentleman has just been elected Vice-President of the Birmingham Branch, a newly-created office; he is also a member of the Parent Association. Mr. F. J. Cook, whose portrait we also reproduce, is Vice-President of the Parent Association, and a member of the Birmingham Branch Council.

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BRITISH FOUNDRYMEN'S ASSOCIATION.

Birmingham Branch.

A MEETING of the Birmingham Branch was held on Saturday, March 28, Mr. R. Buchanan in the chair. A paper was read by Mr. Alexander Fraser on "Notes on Contraction."

The CHAIRMAN, introducing the lecturer, offered his congratulations to the Vice-President of the National Association, Mr. F. J. Cook, on having obtained the diploma of the Society of Mechanical Engineers for the best papers of the season. He (the Chairman) trusted other members would show the same interest in the life and thought of kindred industries, and would also realise the great educational value of the writing of papers. The committal of thoughts to paper gave definiteness to the thoughts and conclusions, and it was often true that the writer of the paper derived more benefit than the hearers. It was always refreshing to listen to new men with new ideas, or to have old facts presented in a new way. They should not stand aside through false modesty or suppose that what they knew was also within everybody's knowledge. Nothing was too well known, and there was an advantage even in the repetition of experiments. Information was especially valuable from those who were specialising in their own particular branch. He was strongly hoping that next year new zest and interest would be given to the Society's proceedings by the coming forward of new men.

With regard to Mr. Fraser's paper, he was personally not well informed on contraction, which was a complex and difficult subject, and he imagined other foundrymen were in no better position. Mr. Fraser's paper, at all events, had the advantage that it recorded problems and difficulties met with in his business. They were all familiar with variations of form which exist sometimes to a surprising extent. The paper, if it did not find a solution, would furnish food for thought.

Mr. Fraser then read the following paper.

NOTES ON CONTRACTION.

If I had named this paper "Notes on Equal Cooling," it would have conveyed to you more clealry what I intend to put before you; and I have named light castings specially, because they show much more plainly and definitely the strains on them due to the unequal cooling of their different parts. Most of us have probably experienced some dismay on opening a mould, to find a casting made from an expensive, and apparently perfect, pattern, either broken, bent away from the shape of the pattern, or twisted; and the frequency with which this occurs when new patterns are brought into the foundry, tells us that this phase of foundry work is far from being an exact science.

For the benefit of those who are not directly connected with the pattern-making and moulding trades, I may explain that the difference in the rate of cooling of different parts of a casting will cause that casting to bend from the form of its pattern, while another of a different design would be broken, either in the mould or by a very slight knock in its dressing or handling. With still another design, the outlines of the casting would be straight, but parts of it which were parallel on the pattern would not be so. This fault I designate as twist, although it is popularly called crosswind.

There are many other faults due to the difference in the rate of cooling, but they are of minor importance, compared with those I have just mentioned, to the makers of light castings. It is not always practicable to add weight, or take it out of the parts of a pattern where it may be

needed, to ensure equal cooling, as lightness is an essential feature in some classes of work, and there are limits as to how thin they may be cast without sacrificing rigidity and strength. Regarding a casting that bends in cooling, the method employed to get it straight is to make a trial casting from the straight pattern, which is usually made of white metal, and see how much this bends and in what direction. The pattern is then bent or cambered about the same distance in the opposite direction, the unequal cooling then bringing it straight; but there are complications met with, which I shall mention later, as regards twists and breaks. These faults, if not very great, may sometimes be corrected by altering the position of the runners, this giving it more or less heat wherever it is needed. This method of re-arranging the runners applies only where the inequality of cooling is not great, or is not spread over much surface; if it is, recourse must be made to either adding weight where the casting cools quickest, or lightening it in the other parts.

In heavier castings, the faults produced by the unequal cooling suffer slight modifications by reason of this difference in weight. The question is often asked: Why does a heavy casting not bend during the cooling process, when a light one of similar design and size does? To explain why this is, let us, for example, take two castings, one an one-eighth of an inch thick throughout, and between 2 ft. and 3 ft. square, the other being the same size but made up to 1 in. thick. The light one would bend on its edges in cooling, and the heavy one would not. The unequal cooling of the centre and edges of the light one produces a stress just sufficient to bend the edges; in the case of the heavy one, if it is made in the same way and under the same conditions as the light one, the stress caused by the unequal cooling is practically the same, as the different parts will cool in almost the same ratio as in the lighter example. As the stress in the first case was just sufficient to bend the thin edges, it is easily seen why the edges of the heavier casting are not bent, as here a much greater resistance is opposed to the stress. Regarding the different results found on those castings, I have heard the theory put forward, that it is the annealing effect produced by the slower cooling of the heavier casting which causes the difference, but this idea need not be entertained, because if this was the case, the metal in the heavier one approaching more nearly to a ductile condition than the metal in the lighter one, it would bend more readily.

Another modification may be instanced by making the centre of the two castings much thicker from end to end, and letting the edges remain as they were. If the addition in thickness were carried to the extreme, a rent across the middle of the heavy casting would be found on opening the mould. This rent or crack would extend from the centre, across the width of the casting to within a few inches of both edges, it being more open in the middle, and gradually closing as it nears the edges. In the case of the light casting, all the difference from the first example would be, that a great deal more bend would be found on the edges. If the thickening of the middle of the heavy casting were not carried quite so far, but still enough to unbalance it, it would show a liability to fracture; even before being taken out of the mould it would go in some instances, the fracture in this case being not in the form of a rent, but as a break right across, severing the casting in two parts. When a break of this nature occurs, if the two pieces be taken and fitted together, the edges will be found to go close enough, but at the middle the pieces will not meet. The explanation of the difference of the fractures of the two heavy castings is this:—We will take the rent first. The balance of the casting is so irregular that the edges are comparatively cold before the middle has solidified, and have, therefore, taken on almost all their contraction. When the middle solidifies it becomes firmly attached to the sides; after this happens the contraction of the middle goes on rapidly, but as it is held back by reason of being attached to the sides, and the latter not contracting as quickly as the middle, it is stretched and ultimately torn across quite gradually, as the cohesive properties of the metal forming it are low at this temperature.

In the case of the second fracture where the bad balance of the casting is not so pronounced, the stretching of the middle does not take place until later in the cooling process, when the cohesion of the middle is much stronger. It withstands the stretching for a period, but its limit is reached in time, and it gives way with sufficient recoil to snap the edges, as well as tearing itself. It has been remarked many times that some parts of a casting contract more than others, and many experienced foundrymen, taking a superficial glance at a bent or broken

casting, would say that this was the cause of the defect. Even some high authorities seem to be under this belief, for in a book of comparatively recent publication, called "Lectures on Iron Founding," there is a short paragraph, with a diagram, showing this difference in contraction as the cause of some breakages. I have here two castings made in exact proportion to the diagrams given, which show that this is not the case.

There is not the slightest doubt that of two castings, a light and a heavy one made from the same quality of metal, the light one contracts the most, it having the higher combined carbon content.

Keep's shrinkage test shows this very conclusively, but I may say that I cannot remember ever having seen, nor can I imagine a casting, in which this factor can cause any of the defects mentioned, and I have proved, by experiment, that it need not be given much consideration, as the greater contraction of the light parts of a casting is always more than counteracted by the later contraction of the heavy parts.

Some time ago I had an order for a number of iron patterns, and the usual course was employed of making a trial from the original white metal one. This trial one was found to bend upwards in the mould, and the pattern was bent downwards to allow for this. When the castings came to be made, instead of them bending upwards, as was expected, they had bent downwards. These castings were made in exactly the same way, were run at the same place, and with the same kind of runners as the patterns, the only difference in the moulding of them being that the first-named were made with their upper surfaces level with the joint of the box, and the latter were sunk in the bottom part about an inch. I guessed at the time, that the alteration of their movement was caused by the sinking in the box, and before proceeding further with them I made a number of trial castings, some placed in the box as the pattern, and some as the castings had been. Others were placed in slightly different positions, but the ultimate result, I found, was, that if they were sunk about an inch, they would bend downwards, although not quite so much as they did when moving upwards.

I do not wish anyone to take this case and the depth of sinking I have given, and apply it to any light casting that bends, as only one particular design has been spoken of, and sometimes a very small alteration in the design produces a great difference in this propensity.

After these trial castings had been made, I desired to know how the uneven cooling acted to cause the difference just mentioned; so I made a number of rough experiments. I observed more closely the castings being made on which the strains were noticeable. The result of a few of these experiments and observations I am going to place before you.

The first lot made was with some castings in the form of strips, 10 in. long, $\frac{1}{2}$ in. thick, and $\frac{1}{4}$ in. wide. They were all cast by a small runner on the extreme end. When made in the sand in the ordinary way, they came out of the moulds practically straight. They were next tried by being moulded with the narrow edges facing upwards and downwards, and instead of the top edge being covered with sand, a flat bar of iron took its place, causing a very slight chill. The next lot were made in the same manner and chilled in the bottom edge, the top being covered with sand. The next were made with the pattern lying flat, some being chilled on the top and some on the bottom. The others were made with the pattern lying as in the last lot, and chilled on the edges. All those that were chilled came out of the moulds bent, the convex side always being the one which was cooled first by the iron chill, but the bends were not all of the same radius, the measurements of them on the lengths of the castings being approximately an eighth of an inch on the one chilled on the top, and a one-sixteenth on the one chilled on the bottom narrow edges. Those made in the flat position, and cooled, one on the top and the other on the bottom, were bent only slightly, with this difference, which applies to all the experiments, that the one cooled on the top always bent more than the one cooled on the bottom. The lot which were cast flat and cooled on the edges bent laterally more than a one-sixteenth towards the side on which they were cooled.

I also experimented with some light flanges of the kind usually found on light castings; they were the same length as the strips, $1\frac{1}{2}$ in. deep, and tapered from $\frac{1}{4}$ in. to $\frac{1}{8}$ in. on their depth; they were also thickened a little on the thick edge to represent their junction with a casting. These were moulded on their edges, some with the thin edge in the bottom part, and some with it in the top. They were not chilled, and were found to act in exactly the same manner as the strips, though not so decidedly.

From these experiments, and what I have observed since they were made, I have found that light flanges on light castings (I lay special emphasis on light

castings, as light flanges on heavy castings do not act in the same manner), invariably bend as the strips did, pulling the part of the casting in their immediate neighbourhood with them.

Now, as to how the unequal cooling acts to cause those bends. First, the metal at the edge of the bar in contact with the chill sets at once, and immediately takes on some of its contraction, while the other edge, which is still in a fluid state, has taken practically none, so that at this stage we get a bar with one edge longer than the other, but perfectly straight. When the fluid side solidifies, the edges are held rigidly in this position, but both of them have to be the same length when cold. The two edges go on cooling until the rate of contraction is revived or stops altogether on the one in contact with the chill. The other edge has still to take some of its contraction, but it now finds some resistance to its inward progress, being tied to the one which is stationary, this being crushed inwards, and at the same time pulling the other outwards. It then resolves itself into a struggle between the crushing and tensile strength of the two edges, and as neither of them give way by breaking they compromise by bending, the crushed edge retaining the convex side of the bar.

There is a time in the cooling process, when by the high rate of contraction of the edge next the chill, the opposite edge will be subjected to a crushing stress, and probably caused to bend in the opposite way to that ultimately found on the bar; but this need not be considered, as it is more than counteracted in the later stages of the cooling. If the ends of the bent bar be examined closely, they will be found parallel; this is out of the common, as the bar has been bent when solid, though hot. If a straight one was to be bent in this manner, while cold, the ends would not be parallel.

There is another point in connection with the bars which requires explanation; that is, why, when the bar bends upwards, it bends more than when it bends downwards. The reason is, that when the chill is at the top of the mould a greater chilling effect is had than when it is at the bottom, therefore, causing greater inequality of cooling. When the chill is at the bottom and the metal is being poured in, it falls at once on the chill, but it is not allowed to cool suddenly by the constant inrush of more hot metal until the mould is filled, so that the chill is comparatively warm before freezing takes place. But when chilled at the top, the mould does not come in contact with the chill until the mould is filled; it is, therefore, colder than the other one, and absorbs the heat from the metal next it more quickly.

I have proved by a number of ways that flanges act on light castings in the manner mentioned, but the simplest is to get a waste casting with a flange on it, which causes a bend, chip off the top of the flange and then examine the casting; it will be found that the bend is not quite so distinct. Then have the remainder of the flange broken off by the root, and the casting will be found to have almost returned to the shape in which it was cast.

I have been speaking about separate and distinct flanges on castings causing them to bend in this way, but there need not be flanges in the ordinary sense of the word to cause this. For example, we will take common roof gutters; such castings may be classed as having flanges. They are usually made in lengths of 6 ft. and upwards, and in most cases are not more than one-eighth of an inch thick. They are usually moulded with their edges downwards, and are cast with a number of flat runners directly on the top, thus adding heat where naturally they would take longest to cool without them, and, therefore, causing greater inequality of cooling between this part of the casting and the edges. Castings of this description take on a great deal of bend, in some cases more than $\frac{1}{2}$ in. on the 6 ft. length. The deflection from the line of the pattern in this case is downwards, the line of the edges being of a convex shape. It will be seen that the extreme edges cool first, and (reasoning from the example of the bars) the other parts draw in, bending the edges and themselves in doing so.

The next experiments engaged in were with bars of the same thickness as the others, but ranging from $\frac{1}{2}$ in. to 3 in. wide; they acted similarly to the others when chilled. After this, a bar about 4 in. wide was tried, and with this came difficulty. When made lying flat and chilled on one edge, the whole casting did not bend laterally as the others did, but it bent upwards, the bend being greatest at the chilled edge and gradually decreasing towards the other side.

This is the bend that is found on light, flat castings, as apart from flanged castings, and if we get at the principles of it, in addition to those of the bend in the first set of bars mentioned, we shall better understand the cause of them on the majority of light castings. In the first lot of narrow bars, the cooling effect

of the chill must extend right across the width. Looking at them in the form of layers of metal firmly attached to one another, we see the layer next the chill contract first, the next layer a little later, and the next later still, and so on, until the other edge is reached, each layer giving the one which cooled in front of it a pull inwards and bending it until at the finish the bend represents the difference between the cooling of the two edges. In the case of the wide bars, the effect of the chill does not go right across; they will cool in layers from the chill, as in the other bars, but only so far as the chill has effect, and probably bend at the edge in the same manner. But beyond the layers we get a part of the bar which cools nearly equally: in the case of this bar it would be about an inch wide.

It will be seen that if the bars were to bend in the same way as the others, half of this inch would be extended, and the other half crushed, but this does not happen. This part contracts evenly on its width, and the more quickly cooled parts give way to it by bending, either upwards or downwards, as the case may be. Reasoning from this, and taking the example of a light, flat plate casting which bends, it will be seen that the edges cannot bend laterally, as there will be comparatively wide parts of it near the middle, with very little inequality of cooling. Any tendency of the edges to go in that direction would be checked by themselves all pulling against one another with equal force; but as the edges must give in some way, to let the centre take its place, they do so as in the wide bar, bending either upwards or downwards. When examined, these bends will be found to be greatest on the extreme edges, decreasing gradually towards the centre. In cases where the uneven cooling is not excessive, they will only be visible for a few inches inwards, but where great uneveness occurs they go right across the casting, the centre bending the edges and the edges the centre. Viewed theoretically, this does not seem possible, as there must be a high tensile stress on the centre tending to keep it straight, but I have found it constantly in practice. I will try and explain it when I reach the subject of baring.

In the case of bars mentioned as being moulded on edge and chilled on top and bottom, the only unequal cooling of any account would be that caused by the chill, as the sides would cool evenly. But in the case of those lying flat, there is another factor to be considered in addition to the chilled edge, which is very slight in itself, but has great influence on the ultimate deflection of the casting. That factor is the greater chilling effect and the more rapid loss of heat through the top or bottom side of the mould. This more rapid loss of heat holds good in most cases, but circumstances sometimes arise which cause the pattern to be sunk some distance in the bottom part; in this case the heat escapes more rapidly at the bottom. I think the explanation of how this factor acts may be seen more clearly from the example of a simple casting, leaving the influence of runners out of the question. Take a casting of a plain, flat plate, about three-sixteenths of an inch thick throughout, and from 2 ft. to 3 ft. square; when this is cast the outer edges solidify almost immediately and take on part of their contraction before the middle commences to contract, and even for a time after the centre is in a solid state, the relative positions of the edges and centre alter by the more rapid contraction of the edges. But there is a time in the cooling when their positions to one another cannot alter and, as then the centre has to contract more than the edges, the latter are drawn inwards in the later stages of the cooling process. Their length cannot be decreased, and as castings of this thickness bend readily, they are bent, allowing the centre to take its contraction with slight resistance.

Now, as to what determines the direction of the bends on the edges, whether upwards or downwards. This is where the rapidity of loss of heat through the top, or, as is the case where the patterns are much sunk in the bottom part, through the bottom side of the casting exerts itself.

It has been noticed that the most quickly cooled part of any casting of simple build always occupies the convex side of the bent part, and that is what happens in this case. Let us take the analogy of a small supple cane suspended by the pressure of the hands at each end. If the cane is straight, and the pressure is kept parallel, it will stand a lot of pressure without bending, but if when under pressure a slight push be given to any side, the cane will bend readily. That slight inequality of cooling, then, between the top and bottom sides of a casting, though it does not cause any visible bend itself, acts in the same way as the push on the side of the cane does, and determines in what direction the casting will bend. I have seen great confusion caused by this slight inequality of cooling; one

case in particular occurs to me. A white metal pattern had been made for a plate 3 ft. 6 in. long. An iron working pattern was wanted from this, and a trial was made from the straight pattern. This was found to bend upwards, so the pattern was bent downwards, sunk in the moulding box about double the distance the trial had risen. The casting from this was expected to rise and reduce the bend by half, but instead of that, it bent further downwards. Another one was made with the same result; those last two seemed to show conclusively that the castings were going to bend downwards, and it was thought that only some extraneous influence or unusual condition had caused the upward bend in the first one, so the pattern was reset with an upward bend, and castings made from it, but instead of going down it came more upwards. The difficulty was finally overcome by adding weight to certain parts of the pattern and therefore causing it to take less camber.

Another case was of a pattern which had gone through the process of trying, and was found to bend upwards. The pattern was cambered to suit this, but when it came to be made, circumstances prevented the use of the same kind of moulding box, the one used for the trial being an ordinary shallow top, and that for the pattern a deep top, the latter, perhaps, being about 2 in. deeper. The trial had bent upwards, but the pattern bent downwards. It was then left until the shallow box could be had, and when made it came out as expected, bent upwards as the trial did.

The reason of the difference in the bends was that in one mould the top side of the casting cooled before the bottom, in another the bottom cooled before the top.

These examples show that in getting out patterns for this class of work as much depends on the moulder keeping the conditions as constant as possible, as depends on the pattern-maker in combining them.

There is a question which is certain to be asked, and that is, "When a casting shows an upward bend, is it the middle of the bent part rising and the ends remaining stationary, or the ends descending and the middle keeping its original position?"

I have tried to determine this by opening moulds very carefully, and noticing how the castings lay on the bottom half, but have been unable to do so by this means. But if the reasoning given for the deflection of the narrow set of bars be followed to a logical conclusion, it will be seen that the middle bends upwards one-half, and the ends go down half of the total sweep. I think this was proved very well during some of the experiments with the bars. In these the chilling effect was given to exaggerate the conditions found in the moulds just sufficiently to make the effects of unequal cooling visible in castings which could be quickly and easily made. So when the first ones were made, a chill was used which it was thought would just give the cooling enect necessary compatable with the conditions just mentioned. The bar to be cast was 18 in. long, $\frac{1}{2}$ in. wide, and nearly $\frac{1}{4}$ in. thick, and moulded on edge, the measurements of the chill being, as far as I can remember, $\frac{3}{4}$ in. wide and $\frac{3}{8}$ in. thick. When the casting was turned out it was found to be a good bit less than $\frac{1}{2}$ in. wide in the middle and to have gained just as much width on the ends as it had lost in the middle, and the chill itself was found as straight as when it was put in. The reason for this was not far to seek, when the mould became full of metal, the chill being so narrow and light got heated on the side in contact with the metal more quickly than on its other side, and expanding more quickly on that side caused a bend; this bending taking place before the metal in the casting was set, it squeezed it out of the middle, going to fill up the spaces left open by the rising ends of the chill. Of course, as the chill was wider than the mould, when the ends rose there would be a space left which, if only the width of the casting was reduced in the middle there would not be enough metal squeezed out to fill the spaces; but besides taking from the width, the downward course of the chill crushes in the sides of the mould, making the casting thinner as well, and displacing as much metal as fills the spaces. Some of the moulds were opened as soon as the metal had solidified, and the chills examined. They were found to be bent in the manner stated, but when the heat became evenly diffused through them, or when cold, they became perfectly straight again.

(To be continued.)

THE second annual general meeting and smoking concert of the Birmingham Branch of the British Foundrymen's Association was held at the Acorn Hotel, Birmingham, on Saturday evening, April 25. The meeting was presided over by Mr. R. Mason, in the absence of Mr. R. Buchanan, the President, who was attending the annual dinner of the South Staffordshire Iron and Steel Institute.

The Chairman remarked that the season had been very successful, and the membership had increased from 52 to 104. Their finances were also very satisfactory, the members having more than covered expenses, which other branches had been unable to do. They had been greatly assisted by lecturers and readers of papers. While the Manchester Branch had to go outside its own membership for good lecturers Birmingham had had valuable help both from the members of the local Branch, and from gentlemen in the neighbourhood. He agreed with the suggestion, which Mr. Heggie, the Secretary, had made, that some evening should be devoted entirely to a discussion on a text-book, or technical book, such as "Keep's Cast Iron," "Turner's Lectures on Ironfounding," or some article or lecture appearing in a trade journal, such as the British "Foundry Trade Journal," or the American "Foundry." The articles should be read, and the members, having been previously advised, would be ready to discuss it. He thought such a change would be appreciated. They must all have benefited from the lectures they had heard, and they had greatly added to their knowledge since the formation of the Branch. Personally, he had found the meetings and the interchange of views very beneficial. They were looking forward to an excellent series of lectures during the coming season. They had been most fortunate in having such a Secretary as Mr. Heggie. Other Branches had been less fortunate, especially that of Manchester, who had recently lost an excellent Secretary through his leaving the district. With regard to the trade outlook, it was clear that a period of depression was approaching. But he believed there was a big future in regard to steel castings. Some of the grey iron companies should lay themselves out for the production of such castings, which would help them to tide over the depression. Malleable castings also would come more and more into vogue, while the successful production of steel castings would greatly help the foundry trade generally. Some foundries were doing this, but the great essential all round was to turn out first-class work creditable to themselves. The great object of their Association was the promotion of efficiency. He was glad to say arrangements had been made for a visit to the establishment of Messrs. Bellis & Morcom, and that opportunity should be widely taken. It was very generous of the firm to allow the visit.

The election of officers followed. Mr. R. Buchanan was again re-elected President for the ensuing year, and Mr. R. Mason was chosen Vice-President. This office, it was explained, is a new one in the Birmingham Branch.

The Secretary, Mr. Heggie, was re-elected, and Mr. E. B. Grover was elected Auditor.

The Council were then chosen as follows:—Messrs. Crump, A. Fraser, G. Hailstone, F. J. Cook, and Craig.

A smoking concert followed, which was much enjoyed by the members.

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CASTING ALUMINIUM IN IRON MOULDS.

In answer to a question as to the method of casting aluminium or any mixture containing aluminium in iron moulds, "The Foundry" publishes the following instructions:—

"When casting, the mould should be heated to a temperature of 120 degrees Cent., and should be coated with a solution of bismuth oxide containing one part of oxide to 10 parts of water. When the casting has been poured, it should be removed from the mould as rapidly as possible. A high percentage of sulphur in the iron from which the permanent moulds are made frequently results in their rapid deterioration owing to the action of the aluminium; low sulphur iron should, therefore, be used. In constructing the moulds an effort should be made to have the walls of an even thickness throughout. The temperature at which the aluminium is poured is an important factor; the metal should not show a reddish tint, as then it is overheated, and will expand too much in the mould." Another correspondent writes that he merely heats the moulds and brushes them with plumbago. He also states that it is sometimes necessary to agitate the metal while solidifying, and this can be done by striking the mould with a copper hammer.

We inspected recently, an aluminium casting produced by the Szekely process. The casting was of an intricate nature that made it liable to shrinkage and distortion, but it turned out quite true, and with a beautiful and regular finish, and was pronounced excellent by the firm for whom the experiment was made.

It is interesting to note that in the methods advocated by "The Foundry" correspondents the preservation of the moulds by coating them with a refractory solution plays an important part.

THE FOUNDRY OF MESSRS. FRASER & CHALMERS, AT ERITH, KENT.

A PARTY of students attached to the Institution of Civil Engineers paid a visit last month to the works and foundries of Messrs. Fraser & Chalmers, Limited, at Erith, Kent, which are situated close to the Thames (upon which the Company have their own wharf) and to the South Eastern and Chatham Railway. The works occupy 17.8 acres, of which 6.5 acres are covered by buildings. They were begun in 1892, and have been gradually enlarged and added to until they are now capable of utilising a force of 1,200 men. Up till 1901 the Company also owned works in Chicago, and shipments were made partly from America, partly from Erith.

Messrs. Fraser & Chalmers are now manufacturing the whole of their machinery at their works at Erith, having disposed of the American works in 1901. The English Company was formed for the purpose of establishing in England the manufacture of high-class mining machinery, and as a step thereto the then well-known American business of Fraser & Chalmers was bought and later sold after it had served its purpose of building up the English trade. The shops are the largest in the United Kingdom, exclusively devoted to mining, crushing, and metallurgical machinery, and are fitted with the most modern tools of the best types built in England, the United States, and Germany, and special provision is made for the erection and testing of large engines, pumps, and compressors.

Special attention has been given by this Company to the design of winding engines with a view to producing the most economical and practical type. Compressors, blowing engines, and pumps, are built under either the Riedler or Gutermuth patents, which are acknowledged to be the best type at present in existence.

The new additional machine shop—402 ft. by 60½ ft.—at the side of the machine shop, is principally used for the manufacture of both high-pressure and low-pressure Rateau steam turbines, pumps, and compressors, and accommodation is provided for special tools and testing floor space. The foundry—360 ft. by 155 ft.—is considered one of the finest shops of this description in the South of England. An excellent view of the interior is shown in Fig. 2. The boiler shop—398 ft. by 133 ft.—has just been doubled in length and allows now of the complete erection under cover of the largest and most modern gold dredges. The types of boilers manufactured are the horizontal, under-feed multitubular, Lancashire, Corliss, and dry-back. In this shop are also constructed the very latest types of steel jacketted smelting furnaces for copper, lead, etc. Also diamond washing and other concentration plants are manufactured by the Company.

The carpenters' shop has recently been rebuilt and enlarged to a building of three storeys, the upper ones being used for the storage of patterns. The pattern shop has also been enlarged to meet the increased amount of work to be handled.

FIG. 1.—GENERAL VIEW OF MESSRS. FRASER & CHALMERS' WORKS AT ERITH, KENT.

The offices are in a separate building, and have been designed to enable the staff to work under the most favourable conditions. The head offices of the Company are at 3, London Wall Buildings, London, E.C., with branches in all the principal mining centres of the world.

Among the great variety of machinery which is manufactured at Erith, the following may be mentioned as receiving special attention and representing special experience in manufacture, viz.:—Driving engines, compound hoisting engines, Whiting hoists, Riedler and Guttermuth pumps and compressors, crushers, stamp mills, grinding pans, tube mills, cyanide plants, concentration mills, Wilfley tables and slimers, frue vanners, smelting furnaces, Bessemer converter plants, roasting furnaces, Blaisdell excavators, continuous filters, coal screening and washing plants, boilers, Rateau steam turbines, Rateau centrifugal pumps and turbo compressors, ventilator fans, diamond washing plants, heavy American type of gold dredges, and the necessary accessories for the various plants.

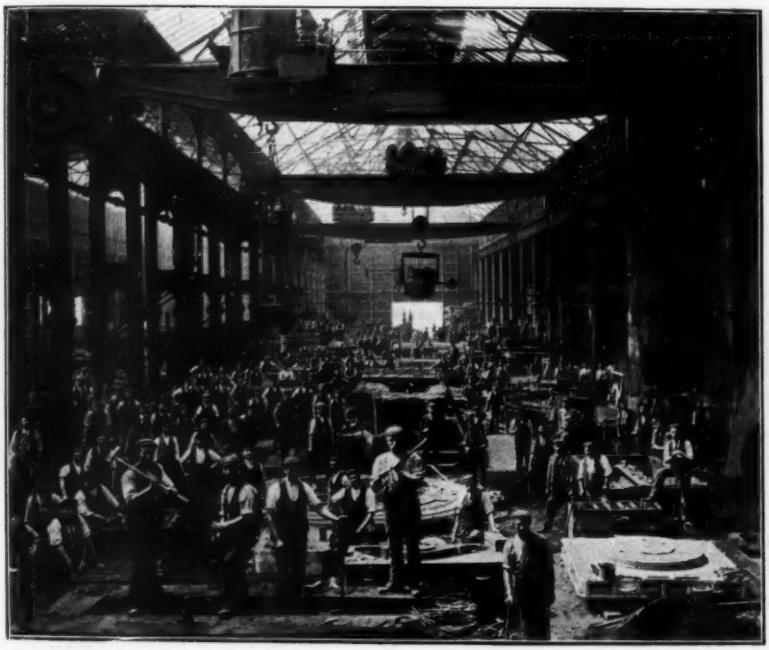


FIG. 2.—FOUNDRY AT MESSRS. FRASER & CHALMERS' WORKS, ERITH.

MAKING THIN CASTINGS.

A NEW method of making thin castings which cannot be cast in a mould in the ordinary way without chilling has recently been patented by G. H. Brabrook, of Taunton, Mass. The patent is based upon the fact that a mould coated with phosphorus allows the metal to run very much thinner, so that when a thin section is to be cast the metal will not chill, but will fill the mould. Thin sections, which heretofore could not be cast in the ordinary manner, may, the inventor says, be satisfactorily cast by the use of this method.

The process is applicable either to sand or chill moulds, and for such metals as brass, bronze, German silver, or sterling silver, red phosphorus is used, as it is non-inflammable at ordinary temperatures. For soft metals, like pewter, or britannia metal, the yellow phosphorus is used.

The mould is sprayed with an emulsion of the red phosphorus and kerosene oil, and the metal poured in the usual manner.

AMERICAN FOUNDRYMEN'S ASSOCIATION.

ACTIVE preparations for the Toronto Convention, to be held June 8 to 12, are now under way.

A radical change from the usual programme for the meetings is contemplated at this Convention. Instead of the reading of elaborate papers, there will be a return to original principles, live subjects being discussed, so that members and their interested friends may have the value of the experience of others along their own lines. Some of these subjects are selected and able speakers will introduce them systematically. In this way, it is hoped, especially as the Convention meetings will be held in an entirely separate building, that the greatest value will result.

It is expected that foundry Canada will be well represented.

The provisional programme includes:—Meeting of the Associated Foundry Foremen; formal opening of the Convention and Exhibition; joint meeting of the American Foundrymen's Association, American Brass Founder's Association, Associated Foundry Foremen, and Foundry Supply Association; official reception at the City Hall; business sessions of the Association; moonlight excursion on the lake; trolley ride; and a smoker.

A Ladies' Reception Committee will see that the visiting ladies are well cared for and entertained. Automobile rides, shopping expeditions, and theatre parties are on the programme for their especial delectation. The same rule which governed the entertainment of members only at Philadelphia will be strictly followed out at Toronto.

A further special invitation goes out to British and German, as well as European friends, who may happen to be visiting. They will be gladly welcomed and cared for on making themselves known to the secretary. Furthermore, visits to the excellent plants of Toronto and other large Canadian cities will be arranged for on notification by foundrymen specially interested.

FIG. 3.—MACHINE SHOP AT MESSRS. FRASER & CHALMERS' WORKS, ERITH.

PROPELLERS.

By W. Ashcroft.

The principle upon which nearly all marine propellers work is the projection of a mass of water in a direction opposite to that of the required motion of the vessel. The screw propeller is the one which has come into general use, and is treated in this article.

The *diameter* of a propeller is a circle which would enclose the extreme points of the blades while in motion. The *pitch* of a propeller, or the pitch of any screw, is the distance a point moving along the

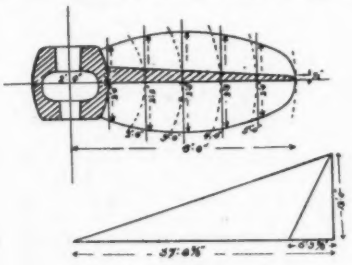


Fig. 1.

helical path of the screw would advance in the direction of the axis of the screw in one revolution. If the pitch of a screw or propeller is 12 ft., it would advance 12 ft. for every turn, providing there was no slip. If we suppose the propeller to be working in some solid material, a nut, for instance, it would advance a distance equal to the pitch, but this is not the case when working in water, as the water yields and is forced back; hence the slip is the difference between the theoretical

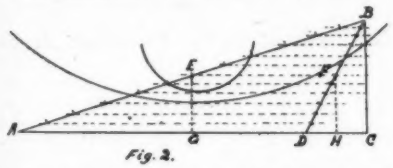


Fig. 2.

distance the propeller should advance, and the distance it actually advances in making one revolution. The slip varies according to the design of the propeller. The following is a detailed account of pattern-shop preparations for the making of in loam, a right-hand propeller, diameter 12 ft., pitch 12 ft., and with four blades.

Fig. 1 is a sketch which would be placed in the hands of a patternmaker to prepare the necessary angles and sweep boards for the loam moulder. Owing to the method of specialising, which is so common in our large pattern-shops, very few of the patternmakers are able to deal with propellers in a workman-like manner, so I will try to make my explanations as lucid as possible.

In the first instance, it will be the patternmaker's duty to draw down the angles, which can be made in sheet iron or wood. Now it is not necessary to draw down the full size of the angle as given

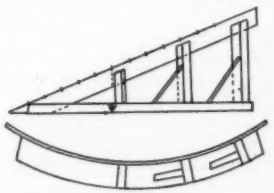


Fig. 3.

on the sketch, but only so much as will ensure you being able to get the full width of the blade; in the majority of cases one-sixth would be sufficient.

In Fig. 2 will be seen the drawing necessary for iron angles, which are now very often used, especially the inside angles. Sometimes the outside angle is made in wood, then Fig. 2 is not necessary to the patternmaker.

In Fig. 3 is shown a wood angle; the radial base is made about 5 in. or 6 in.

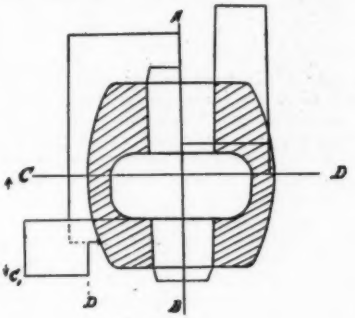


Fig. 4.

wide, with a few uprights strong enough to sustain a piece of wood about ¾-in. thick and 4 in. wide, being bent round them at a radius of 6 ft., the same to be divided off into twelve equal parts, as shown in Fig. 2, and the centre projected down to the base.

Referring to Fig. 2, A B C is the angle

formed for the outside of the blade; that is, at 12 ft. diameter, and B C D is the angle formed to be set against the boss in this case, seeing that the boss happens to be 2 ft. diameter. But this method is not absolutely necessary; angles can be placed at any reasonable distance from the centre of the boss, providing the base of the angle is made the circumference of the circle at which you wish to place the angle away from the boss and the height of the perpendicular the pitch given, as in Fig. 2. A C is the circumference of circle with angle standing at 12 ft. diameter, and C B is the pitch, also D C is the circumference of circle for angle standing at 2 ft. diameter, and C B the pitch. As I said before, it is not necessary to use the full-sized angle, but for convenience, and also to save brickwork in the foundry, it is policy to cut as much

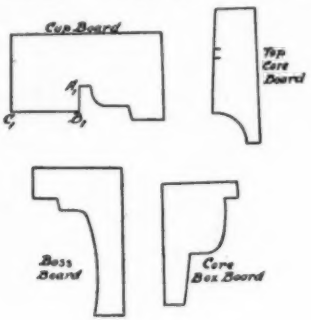


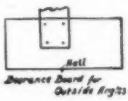
Fig. 4a.

off the angle as possible; although one-sixth of the full angle is generally used, it is not binding. The main point is, that whatever you make one angle you must make the other one in the same ratio, not forgetting, of course, to allow for the full width of blade. I have divided the angles into twelve equal parts, with the centres at E and F projected down perpendicular to the base at G and H, but, of course, you can divide them into as many parts as you wish, providing each are divided alike and are sufficient to ensure a true bed when strickled over in the foundry.

After the patternmaker has the angles ready he will find it necessary to get sweep boards ready for the boss. For his own convenience, as well as for the moulder's, it would be as well to draw down half of the illustration (Fig. 4), the left half of the centre line A B for preference. There are four boards necessary for the boss shown, and I will illustrate each one singly, their relative positions being shown in Fig. 4.

A board, called the "cup board," is generally made first. The line A_1 B_1, shown on small sketch (Fig. 4a), is made to sweep the diameter at which the inside angle is made to stand; in this case A_1 B_1 will be cut 1 ft. from the centre, shown in Fig. 4 by B D. C_1 B_1, on the sketch of cup board, is a bearance for the inside angle, the measurement for which is given in Fig. 2 by F H, and marked on Fig. 4 by C C_1. The second board required, called the "boss board," is made to fit the boss from the joint which is made by the cup board. It will be noticed when these two boards are brought into use in the foundry a loam pattern will be formed, with prints swept on for the centre core.

Fig. 4 shows the bottom part of the core formed by sweeping out a core box, which is very simple and accurate. The three boards shown in detail are all made to fit against a central pin, so that although Fig. 4 shows them touching the centre A B, they will have to be cut to come against the pin to which they will be bound in the foundry. The "top core board" needs no explanation, other than it should be made long enough to allow the moulder to make 4 in. or 5 in. of print; that is, to carry the core 4 in. or 5 in. above the top of the boss. There is still one sweep board to make for a bearance for the outside angle; this is just a plain, straight board, with a nail put in somewhere about the centre. In the pre-



sent instance, the board will be fastened so that the nail will make a mark on the bearance at 6 ft. from the centre A B, the bearance to be on the same level as the bearance made for the inside angle, and also to be at right angles to the centre line A B on Fig. 4.

Now that the sweep boards and angles have been finished, a set of templates for the thickness of the blades will next require the attention of the patternmaker. Turning to Fig. 1, the thickness will be found to be 5 in. one foot from the centre and ½-in. six feet from the centre. The practical workman will proceed to draw down upon a board a drawing similar to Fig. 5, which shows a horizontal line, 5 ft. long, with five vertical lines drawn 1 ft. apart. A line is next drawn cutting the

end vertical lines at 5 in. and ½-in. respectively, from the horizontal line. Again, turning to Fig. 1, 2 ft. is the breadth of the blade against the boss, so that your

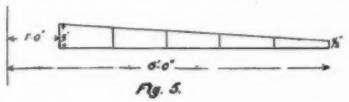


Fig. 5.

templates, about a quarter of an inch thick, will need to be cut, 2 ft. long, 5 in. high in the centre, and running off to a point at each side of the centre similar to the sketch (Fig. 6). Each of the four remaining templates are made in like manner, that is, with breadth of blade given in Fig. 1 and height taken from

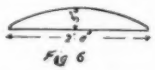


Fig 6

Fig. 5. Although this concludes the work connected with a propeller in a pattern-shop, the patternmaker is still required to "mark off" in the foundry. This will be treated with in a future issue.

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Tube Mill in Dispute.—An appeal from the Sheriff Court at Glasgow by the plaintiff in an action by T. Thomson, engineer, Glasgow, against J. Evans & Company, blacking manufacturers, Glasgow, was heard in the Second Division of the Edinburgh Courts, recently. The plaintiff sought to recover £260, the price of a tube mill for grinding moulders' blacking. The defendants resisted the action on the ground that the plaintiff had given a warranty that the mill would not require more than 15 h.p. to drive it, and would turn out a certain definite quantity per hour. Sheriff-Substitute Fyfe held that the warranty had not been made out, and granted decree in favour of the plaintiff. The defendants appealed, and Sheriff Guthrie reversed the Sheriff-Substitute's interlocutor, holding that the warranty had been established, and assoilzieing the defendants. The Second Division subsequently sustained the appeal, and reverted to the decision of the Sheriff-Substitute, with expenses to the plaintiff, holding that anything he had said was nothing more than a representation, and did not amount to a warranty in law.

THE MANUFACTURE OF INGOT BRASS.*

There are few matters in the brass foundry upon which a greater diversity of opinion exists than in the use of ingot brass. Many founders will not use it at all. Others prefer it to anything else, and do not purchase any other raw material. One brass founder will say that he has never been able to obtain satisfactory results from it; the price may be right but the quality is lacking. Another will say that he can obtain ingot brass perfectly suitable for his work, and as it is much cheaper than the same mixture made from new metals, he can see no reason why he should not use it.

It seems paradoxical that there should be two such opposite opinions; yet both are right. The founder who uses ingot brass continuously is able to purchase a satisfactory quality. The other one has not been able to do so. Either the mixture has not been suitable for his work or the brass has contained iron. The fact that large quantities of ingot brass are manufactured and sold is evidence that it is possible to make a good metal; but at the same time, equally large quantities are manufactured which should never be used in the brass foundry, and are only fit for the copper smelter.

Brass Ingot a Scrap Material.

As recognised in the brass foundry trade, ingot brass is made entirely from scrap metals. It goes without saying that a brass founder can make his mixtures from new metals as cheaply and as well as anyone else. The advantage of ingot brass lies wholly in the fact that, owing to the use of scrap metals in it, its price is considerably lower than the same mixture made from new metals. While it is impossible to control scrap mixtures with the accuracy of those made from new metals, it can be done within limits that are quite satisfactory, and will satisfy any requirement except the most exacting. To make such ingot, however, requires a knowledge of metals usually beyond the average scrap metal "smelter and refiner."

The quality of the scrap from which ingot brass is made is most important. It will not suffice to make a yellow brass ingot from anything in the scrap line that is yellow, nor to make a composition ingot from car brasses. To be

* "Brass World."

able to make a good ingot metal, it is necessary to know what the requirements of the brass founder are. A yellow brass ingot must have some other properties besides being yellow. It must be of the required mixture or as nearly so as it is possible to make it from scrap metals.

Ingot Brass Specifications.

Let it be understood at this point, that where strength, fine dipping qualities, uniformity in colour or other severe requirements are to be met, ingot brass should *not* be used. It will be impossible to meet them. Scrap metals vary too much in mixture to admit of their being used in such work. Neither can ingot brass be used for castings which are to be free from lead, as there is very little scrap brass on the market which does not contain lead. In fact, the amount is so inconsiderable that it is of little importance. Practically every kind of scrap brass contains it. For the majority of uses, however, such a lead content is advantageous.

While it is impossible to draw up specifications for ingot brass which will meet every requirement, the majority of its uses are so nearly the same that one mixture may be made to serve nearly all of the different requirements. In fact, ingot brass-makers usually make but one kind, and this is expected to answer for all requirements. It usually does.

A good yellow brass ingot, suitable for general brass foundry use, should conform to the following specifications :—

Copper—not less than 65 per cent. nor more than 70 per cent.

Spelter—not less than 25 per cent. nor more than 35 per cent.

Lead—not less than 2 per cent. nor more than 4 per cent.

Tin—not over 1 per cent.

Iron—not over 0.5 per cent.

Nickel, antimony, or manganese—not over 0.5 per cent., and none if possible.

Aluminium—none.

If less than 65 per cent. of copper is present, the brass will contain so much spelter that dirty castings are apt to result. When more than 70 per cent. is present the mixture is usually too soft, although it casts well.

The spelter content, of course, is proportional to the amount of copper in the mixture, so that when the copper is low the spelter is high. The preceding remarks about the copper will, therefore, apply to the content of spelter as well.

Lead is an important ingredient in the brass. If too little is present, the brass will not cut freely. If in excess, it will not cast well. The lead will separate in spots, and the castings made from it will be brittle. With less than 2 per cent. of lead, yellow brass does not cut freely. When over 4 per cent., it is brittle. As scrap brass contains varying amounts of lead, to keep the lead even to the preceding limits (from 2 to 4 per cent) is difficult. There is little danger, however, of its being less. It usually will run more.

Tin in yellow brass hardens it. Even as small a quantity as 1 per cent. has an appreciable hardening effect. The majority of yellow brass ingot sold contains none, but the presence of about 1 per cent. stiffens the castings so that they are better suited for many purposes. The foundryman can easily add it, however, if he finds that the brass is not sufficiently strong. When present in an amount over 1 per cent., the brass becomes too hard for many uses.

The foundryman, therefore, has in tin an elastic ingredient, and by adding it, his yellow brass ingot may be hardened to any desired amount. In the majority of instances about 1 per cent. is to be preferred in the mixture. Such a mixture as that used for gas-cocks, for example, is improved by the addition of this small quantity of tin, as the castings are then better suited to stand the machining without distortion.

Iron is the source of the greatest amount of trouble in yellow brass ingot. It is quite difficult to obtain scrap entirely free from it. As long as it is *combined*, however, it has no effect other than to harden the metal. But when present in the *uncombined* condition it is sure to cause trouble. By *uncombined* iron is meant that which is in the brass in the form of shot, pieces of wire, screws, and other shapes. These were originally in the scrap brass that was melted, and did not combine with the metal. In machining, they will greatly injure, if not actually ruin tools, and even though one small shot may be found, it indicates that others are present, and it is usually not advisable to continue the use of the ingot.

As far as *combined* iron is concerned, it may be said that unless over 0.50 per cent. is present, the brass is not hardened so as to be injured. When over this quantity is found, the brass may be too hard to machine. Iron hardens brass as rapidly as tin.

As far as nickel is concerned, a small quantity has no influence upon the brass. Large quantities harden it. Other than the hardening effect, nickel is not injurious, and can be overlooked. It enters brass from the presence of nickel plated scrap, German silver, or other nickel alloys.

Antimony renders brass brittle, but in small quantities it has such a slight effect as to be disregarded. It should not be present in a quantity of more than 0.50 per cent., however, as a larger quantity causes brittleness.

Manganese is not apt to be present, but the increasing use of manganese alloys may now and then cause it. Its influence is a good one when present in small quantities, as it produces sound castings, but large quantities harden the brass.

Aluminium is a most injurious ingredient, and should never be present in ingot brass. While there are instances

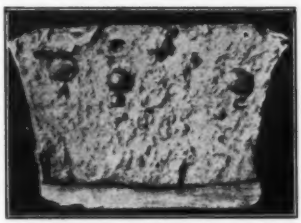

FIG. 1.

in which a yellow brass containing aluminium can be advantageously used in making castings, the brass founder had better add it himself. He then knows the exact quantity that is present. If it is present in the ingot, its quantity is unknown, and it may be present in such an excess as to cause much trouble. Specifications should call for the complete absence of aluminium.

Summing up the preceding specifications, therefore, a good yellow brass ingot should contain the following :—

	Per cents.
Copper	65-70
Zinc...	25-35
Lead	2- 4
Tin	0- 1

Iron, antimony, nickel, and manganese should be absent if possible, but as this is usually impossible in the use of scrap, not over 0.50 per cent. of each should be permitted. Aluminium must be entirely absent.

The Raw Material for Making the Ingot.

As there are so many kinds of yellow brass scrap found in the scrap metal trade, it would not seem a difficult matter to find suitable raw material for making yellow brass ingot. Let some of the different scrap metals that are available be considered :—

Yellow washings can seldom be used on account of the iron they contain. Even though magneted, iron will remain. This is explained by the fact that the iron may be attached to a piece of brass and the whole carried past the magnet. Washings always give hard metal, and unless of extra quality, such as those from a rolling mill, they are rarely used for making good ingot.

Grindings are so difficult to melt without excessive loss that they are not considered economical. The resulting metal, too, is apt to be hard and of uncertain composition.

FIG. 2.

Skeleton brass is undoubtedly the best material for making the ingot, but its cost is so high that it prohibits its use. The fact that the brass rolling mills purchase such material is responsible for the price.

Condenser tubing is a good material when it can be obtained, and at times it can be purchased at a satisfactory figure. It is free from iron, but is often so dirty that the melting loss is excessive.

Heavy yellow brass, such as faucets, gas cocks, and a miscellaneous assortment of medium-sized castings, cannot be used on account of their cost. They can be used without putting into ingot and brass foundrymen will, accordingly, pay a good price for them. They make good material when they can be afforded.

Light brass, such as old lamps, clocks, burners, fixtures, bedstead tubing, upholstery, hardware, etc., are a cheap class of material and the favourite raw material of smelters who desire to make a *cheap* brass ingot. It is the cheapest material that can be used for such a purpose. The iron which it contains, however, is the objection to its use. It is practically impossible to remove it entirely. Skimming, no matter how carefully it is done, will not completely eliminate it. Fluxes also fail. The result is an ingot full of iron. Although the iron may not be visible to the naked eye, when machining is done upon it, this is revealed, much to the disgust and financial loss of the user.

In Fig. 1 is shown a yellow brass sand casting which contained iron. The metal gave much trouble in machining. Hard, steel-like spots were found. One of the castings was fractured and the result is shown. The steel nodules A B C are caused by the actual melting of iron and steel, and when they solidify they chill and become so hard that a file will not touch them. If the brass is not overheated, however, the iron or steel usually does not melt and remains in the brass in its original condition.

In melting light brass which contains iron (and it invariably does contain it), no matter how carefully the pot is skimmed, some of the small pieces of iron will remain in the metal. Floating to the top of the brass as they do, one would naturally believe that every piece could be removed by careful skimming. Those who have attempted it know how difficult it is. Minute rivets, screws, and other particles of iron or steel cannot be felt with the skimmer. The large pieces are easily removed.

In Fig. 2 an ingot is shown which contains pieces of iron. This ingot was made from light brass, and the crucible containing it was very carefully skimmed. From the "feel" of the skimmer, the brass was pronounced free from iron, and it was, therefore, poured into ingots. The result is shown.

It will readily be appreciated that although light brass is a cheap material, the brass in it is nearly all sheet metal, and though of excellent quality, the presence of iron prevents its use for good ingot. Were a certain method known for removing the iron, light brass would be the cheapest and best material for the purpose.

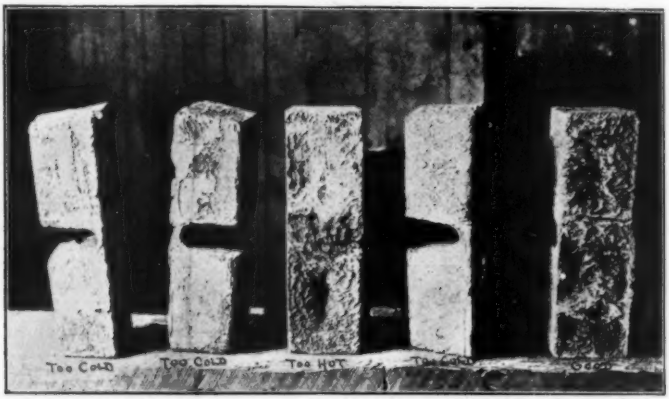

FIG. 3.

Yellow brass chips are the material from which the greater proportion of yellow brass ingot is made. They are produced in large quantities, are of very uniform quality, and can be purchased at a price that will allow of their use. Some of the largest makers of ingot brass use nothing else. While there are small quantities of other materials, such as condenser tubing, punchings, clippings, or other varieties of scrap that can be used equally as well as chips, they cannot be obtained in sufficient quantity to allow of exclusive use. Chips, however, are a constant and large supply of raw material.

As yellow brass chips supply the greater part of the raw material from which yellow brass ingot is made, the discussion of the manufacture of the ingot in-

volves the complete treatment of the chips.

Kind of Yellow Brass Chips Used.

The best yellow brass chips for making ingot are those from screw rod, as this material is very uniform in mixture and contains sufficient lead. In melting, too, just enough spelter volatilises to give the right copper content in the ingot metal. Yellow brass screw rod is used upon automatic machines for making screws, studs, knobs, and a large variety of similar work. Large quantities are used, and a corresponding quantity of chips are produced. Chips from castings, while not as good as screw rod chips, may also be used.

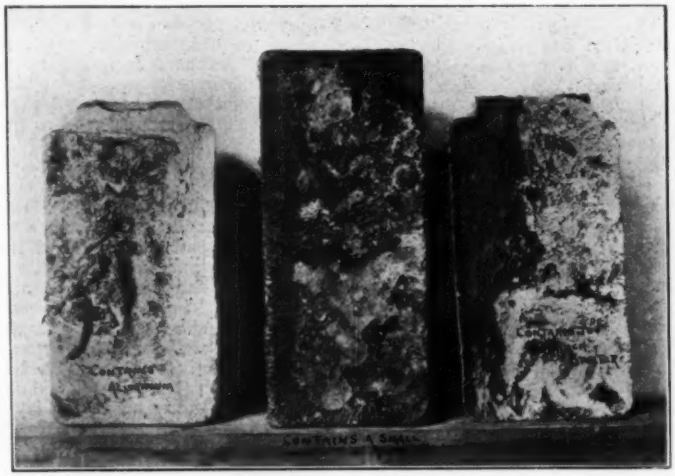

FIG. 4.

Screw rod from which chips are made, generally has about the following composition: —

	Per cent.
Copper	62.50
Zinc...	35.35
Lead	2.25

And with the two meltings which are made (first in making the ingot and next in melting the ingot for making castings) the spelter will be reduced to between 30 and 35 per cent., or the right amount for successful sand casting.

Melting the Chips.

The best results are always obtained in melting chips by the use of a large crucible. The waste is the difficulty to be overcome. While theoretically the loss is the same in a small or large pot, the mechanical loss by carelessness in charging is less in a large pot than in a small one. If a melter is slovenly in his methods, he will usually lose a large quantity of chips by their falling into the fire when the pot is charged, and if a large one is used the loss is less. The use of a funnel in charging greatly lessens the loss.

A large pot, such as a No. 200, is excellent and is used in many establishments making ingot brass. While furnaces other than those which use crucibles may be used, special treatment is necessary in order to avoid loss.

The chips are charged in the crucible and care taken to avoid overheating. In this manner the loss can be kept at a minimum. With careful melting the loss in melting yellow brass chips can be kept down to 5 per cent., but in ordinary instances it will run to 10 per cent. and over.

The pot should be well skimmed before pouring in order to obtain as clean ingots as possible. Appearance has much weight in selling, and to turn out an ingot full of dross frequently results in a dissatisfied customer.

The heat at which the brass is poured has much to do with the appearance of the ingots. If too cold, they will have the spots of dross in them as shown in Fig. 3. On the other hand, an ingot poured too hot will shrink like the middle one seen in Fig. 3.

The moulds should be lightly oiled with lard oil in order to produce a good surface upon the ingot and allow its easy removal.

Size of Ingots.

Ingot makers usually make a mistake in producing too large ingots. The majority of brass founders use a small crucible, and when the ingot is placed in it, the top projects out to a considerable extent. While the ingot may be broken if the web between the heels is not too large, this involves labour that is unnecessary. Small ingots weighing about 10 lbs. and narrow so that they can be inserted in a small crucible without difficulty are by far the best and are desired by brass founders.

Effect of Aluminium.

As aluminium has now come into extensive use, and is used in yellow brass, ingot makers will have to exercise extraordinary care in order to prevent its entrance into their metal. The appearance of the top of the ingot is usually a good indication of the presence of aluminium, and in Fig. 4 are shown two ingots which contain it. In the left-hand one, the brass contained about 0.50 per cent. of this metal, and the smooth appearance of the top should be noted. In the middle ingot, only a few hundredths of a per cent. was contained, but its presence was manifested by the spotted look. A good ingot of yellow brass should have a very rough top and without patches of smooth surface.

Magnet Machine.

In making ingot from yellow brass chips, the advantage of a good magnet machine should not be overlooked. No matter how careful the makers of the chips may have been, even though no iron or steel were machined in the shop, these metals will surely find their way into the brass unless the chips are carefully magneted. Taps, drills, nuts, or broken machine parts are always found in chips. The maker may have taken care to do his machine work in a place where it would seem that no iron or steel could get in, yet the magnet will demonstrate that this is not so. To make a good brass ingot from chips requires that a good magnet machine be used, and that the magneting be carefully done.

Conclusion.

The question naturally arises, why the brass founder himself cannot use the chips and not pay a profit to the brass ingot maker? There is no secret or extraordinary knowledge required in the making of it, and every brass founder has the appliances.

The question resolves itself into one of buying the chips to a good advantage. Unless this is done, it will be discovered that ingot brass can be purchased at a less cost than the chips. Those who make brass ingot on a large scale have facilities for purchasing the chips at the lowest market rates. This a small brass founder is seldom able to do.

Unless the chips can be purchased at the lowest market price, it will be found that the ingot brass is the most economical. Chips need to be melted and poured into ingots in order to make satisfactory castings, and when the price is right and the quality good a brass founder will find that ingot brass is the most economical metal he can use. To use it in a satisfactory manner, however, he must use judgment in employing it for his castings. It will not answer for all kinds, but for many it is equally as good as new metal.

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Use of Magnesium in Bronze.—The fact that magnesium is such a strong deoxidising agent has rendered it valuable in making sound copper castings and in the production of malleable nickel. Although tried in bronze and brass, the results first obtained were unsatisfactory, on account of the use of too great a quantity. Not only is there no need of adding a large quantity of any deoxidising agent, but in many instances it is positively detrimental. In phosphor-bronze, for example, an excess produces pinholes and other imperfections in the casting, but a small quantity acts in a beneficial manner.

With magnesium the same is true. Some recent experiments made with this metal in bronze sand castings demonstrate that in small quantities it has a beneficial effect. The metal is very close-grained and has physical properties superior to metal without it. The quantity added was 0.05 per cent., which is amply sufficient for deoxidising purposes. Probably half this quantity would give even better results in alloys which contain zinc, such as brass or bronze, for the reason that there is less oxide to be reduced than in metals like copper or nickel. This fact has been demonstrated in the case of phosphorus, and it is customary to use a smaller quantity in brass than it is in the copper and tin mixtures. As magnesium is a metal, it is, theoretically, a better deoxidising material than a non-metallic substance like phosphorus.

The "Foundry Trade Journal" Bookshelf.

It is proposed, on this page, to deal with various books likely to prove of interest and instruction to any branch of the Foundry workers, and not only new books appearing will be reviewed, but any that are now on the shelves and are obtainable from the publishers.

An endeavour will be made to present the salient features of these books to our readers, so that those desirous of advancement may learn to some extent what publications will best meet their requirements.—THE EDITOR.

Microscopic Analysis of Steel.

By Floris Osmond, Paris.

Edited by J. E. Stead, F.R.S., F.I.C.

THE prominence now given to the examination and analysis of metals by means of the microscope lends a particular interest to any literature on the subject that emenates from authoritive quarters. Of such interest is the above work. The book consists principally of two papers; the first on "Metallography Considered as a Method of Assay," read before the International Association for the Testing of Materials, at the Stockholm Congress in 1897; and the second paper treating with "Micrographic Analysis of Carbon Steels." Appended are also a chapter describing the micro and photographic apparatus used, and a chapter on austentite.

The author commences by defining the term metallography, and then proceeds to divide the science into the following subdivisions, viz., anatomical, or the identification of individual constituents; biological—internal, treating with the transformations which occur in the life of metals and alloys under the influence of heat and pressure; pathological—the diseases of metals, represented by incipient fractures, slag inclusions, planes of weakness, and metals in which weakness has been produced by improper treatment.

The second paper describes a general method for the micrographic analysis of carbon steels, commencing with the rough polishing for a section and describing the successive operations and the requirements to be fulfilled for successful work. The author then follows with a consideration of the various constituents of carbon steels.

A chapter is devoted to the micrographic identification of the constituents and a detailed examination of selected steels, and the influence of annealing and quenching is then considered. The author's conclusions, theoretical and practical, are given, and a brief description of the apparatus employed for microphotography, and some remarks on the constituent austentite, as compared with hardenite, complete the book. Photographs and diagrams, numbering over one hundred in all, illustrate the subjects dealt with.

The author pays tribute to the researches of Sir William Roberts-Austen, Professor Martens, Dr. Sorby, and other prominent scientists who have contributed their endeavours to discoveries concerning the subjects so acceptably treated in this book.

Publishers.—Charles Griffin & Company, Limited, Exeter Street, Strand.

The Art of Pattern Making.

By I. McK. Chase, M.E.

THE expressed intention of the author in placing this book before the trade is to enable those interested to gain knowledge which the experience of one man alone is not likely to bring. Hence, the work is fairly extensive in its scope, embodying the experience of various workers in pattern making. A very varied description of work is treated with, including what are recognised as some of the most intricate jobs a pattern-maker can be given to do. The introductory chapter is in itself extremely interesting, touching as it does on the origin and rise of pattern-making as we have it to-day. The equipment and management of a modern pattern shop occupies two chapters, and then follows a series of articles, each dealing with some particular class or piece of work which might be placed in the hands of any pattern-maker. The different classes of work considered can best be indicated by an enumeration of some of them. Some remarks on loam moulding are followed by chapters on pattern work for a cylinder, an elbow, steam cylinder of marine engine, a pedestal, screw propellers when swept in loam, a launch

engine, a water collar, a high-pressure cylinder for marine engine, a screw propeller cast entire, and also with separate blades, belt pulleys and flywheels, teeth of gear-wheels, standard patterns, and other pieces of work. Loose pieces, wood lagging for an elbow, a wooden faceplate, and wax fillets are among other things treated, and consideration is given to the lathe and lathe work, marking, recording and storing of patterns, and handy tools for pattern makers. The various sectional linings in mechanical drawings and their significance are illustrated and explained, and some useful hints on practical geometry are given. The author gives also some useful hints for dealing with the various problems of measurement and calculation, which are frequently met with in the workshop, and supplementing these are tables and instructions for computing the volume of timber; tables showing the strength and weight of woods, decimal equivalents, mensuration of surfaces and solids, nails for pattern work, wood screws, etc. The information embodied in the book should make it of immense service to pattern-makers, and while the variety of subjects treated does not permit of an extensive treatise on each, the information contained is of an eminently practical character.

Publishers in London: Messrs. Chapman & Hall, Limited.

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Malleable Iron Castings.—It is estimated that the production of malleable iron castings in the United States in 1907 amounted to 969,400 tons. The producing capacity is now about 1,300,000 tons a year, as against 875,000 tons in 1903—an increase of about 50 per cent. The net increase in the number of malleable foundries since 1903 is 15, the number of new plants being 17, and of abandoned plants 2. The statistics just gathered show that 13 new plants have been put in operation since July 1, 1906. At present there are 151 malleable foundries in the United States. Ohio and Illinois lead with 21 each, New York and Pennsylvania have 16 each, Wisconsin has 12, Connecticut 11, Michigan 8, Indiana 6, New Jersey 4, Massachusetts 3, Missouri 2, and Alabama, Delaware, Iowa, Kentucky, Maryland, Minnesota, New Hampshire, Rhode Island, Tennessee, Washington, and West Virginia 1 each. The number of air furnaces in use at malleable foundries is 369, and of open-hearth furnaces 21. In addition 42 cupolas are used for melting iron entering into malleable castings.

CHARGING MACHINES FOR FOUNDRY CUPOLAS.*

By G. R. Brandon.

Machines similar to those described in this paper are in successful operation, and are practical, both from mechanical and financial standpoints. The very simplicity of the work of collecting charges and of the operation of charging itself has induced neglect of this important department. A little study of methods might lead to the adoption of a more efficient vehicle for carrying charges, the use of cars, for example, with roller bearings and running on tracks, instead of wheelbarrows. The arrangement of tracks to permit through routing and the location of a scale for the weighing of charges are of an importance frequently overlooked, and it is surprising that in this enlightened day the long inclined plane taking up much valuable space and with its laborious methods is still used in place of the modern elevator.

Where the material handled is in sufficient quantity, a quick-acting electric traveller should be installed to cover the entire stockyard, to unload pig-iron, fuel, and supplies, and also to handle flasks. A magnet can be used for handling pig-iron, and a drop ball for breaking scrap, with distinct advantage. Charges may be collected from different parts of the yard and raised to the charging floor by a crane at minimum expense. The charging operation lends itself to power manipulation and, consequently, at this point we may also obtain a saving in labour.

This paper describes the charging machine developed and manufactured by the Whiting Foundry Equipment Company, Harvey, Illinois, U.S.A. Its designers are indebted to the blast furnace operators for the idea of the machine. The skip hoists and their great saving effected over the old practice of using elevators and dump buggies pushed by labourers are familiar. This refinement in handling charges naturally was introduced by the blast furnace people, as their operations are continuous for months, 24 hours a day. The elimination of labourers effected great economy in the cost of production and is one of the reasons why pig-iron can be purchased at such low prices—occasionally.

* Abstract of Paper read, March 2, before the Pittsburg Foundrymen's Association.

The skip hoist is an end dump and is fitted with automatic features which would not be applicable to the conditions in cupola practice. The makers of the machine under notice have adopted the side dump, which is claimed to be a simpler design and a better arrangement for the continuous movement of cars. Other advantages are that there is less handling of cars and a narrower charging floor is permissible.

Fig. 1 is an elevation of the machine with car in position ready for raising, and Fig. 2, the same in dumping position. The machine consists of a platform hinged at a level above the charging platform on the side toward the cupola, provided with a track for the charging car, in line with stationary tracks, guard angles, as shown, and a hook for holding the car to the platform when being dumped. A dumping cylinder is properly supported by framing attached to the charging floor and pivoted to allow the alignment required. The piston rod is pivoted in a bracket attached to the under side of the platform. The platform is constructed of structural shapes and all joints are strongly riveted; the hinge pins are of ample size, and are arranged for easy removal and replacement. An apron plate is hinged to the platform and laps over an inclined chute in front of the cupola doors. The controlling valve is located at any convenient point and is piped to the cylinder and connected with an air supply.

In operation, the car is run on the platform and the hook engaged with an eye attached to the car frame. Then the valve is opened to admit air into the operating cylinder and the platform is raised to the dumping position. Iron charges are put on cars with ends about 12 in. high, but open on both sides. Coke cars have their ends and sides enclosed, one side being fitted with a hinged door.

Through manipulation of the valve, charges may be distributed as desired. The level of charges must be maintained 3 to 4 ft. below the level of the door sill to get the best results. Electric power may be used in place of compressed air, by using a geared hoisting machine. The ordinary crane controller will give the different movements and speeds required.

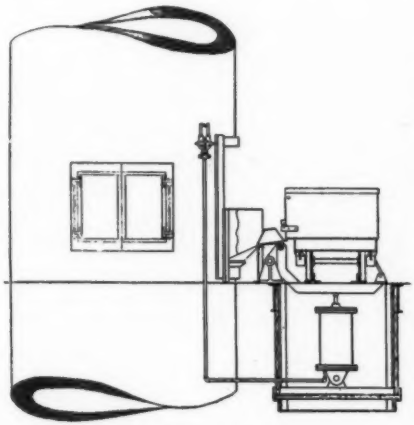

FIG. 1.—LOW POSITION.

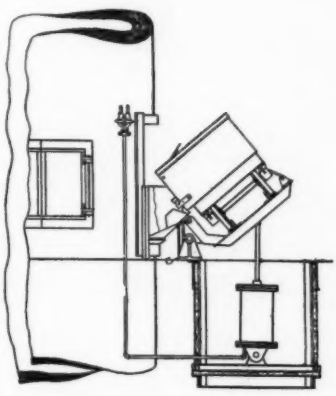

FIG. 2.—DUMPING POSITION.

CHARGING MACHINE FOR FOUNDRY CUPOLAS.

A device of this character is necessarily of the greatest benefit where the cupola output is large and the speed of melting relatively high. A cupola 54 in. diameter inside of lining is about the smallest size which should be charged by machine. With a cupola having a 90-in. shell, 72 in. inside diameter, and melting 20 tons per hour, two men with the charging machine can perform the work which would otherwise require five or six men. Assuming the duration of the heat to be four hours, the saving in

labour will be 12 hours' time at, say 8d., or 8s. per day, which represents an annual saving of £120.

The charging door in the cupola for use with this machine is 9 in. above charging floor. To obtain the maximum economy of fuel the charging floor should be from 20 to 24 ft. above the bottom plate, or about 5 ft. higher than for hand charging. Other charging doors, at ordinary height for hand charging, are located at the sides for use in emergency, and for levelling the stock charged by the machine if this should ever be necessary.

Fig. 3 shows a compound machine for use in connection with low charging floors, consisting practically of an elevator of the plunger type, which lifts the car and charging machine together to the required level. The two mechanisms are controlled independently, and may be operated by pneumatic power, as shown, or by electric power. The original charging doors may be left in the cupola, being shifted as necessary and used for hand charging and levelling.

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A USEFUL publication for those who have plant and machinery for sale, or who wish to purchase, is "Phillips' Monthly Machinery Register," and "Electrical Machinery, Motor Car, and Steam Wagon Supplement." It is a medium for introducing customers to those who have machinery for sale, and is published by Mr. C. D. Phillips, M.I.M.E., Emlyn Engineering Works, Newport, Mon.

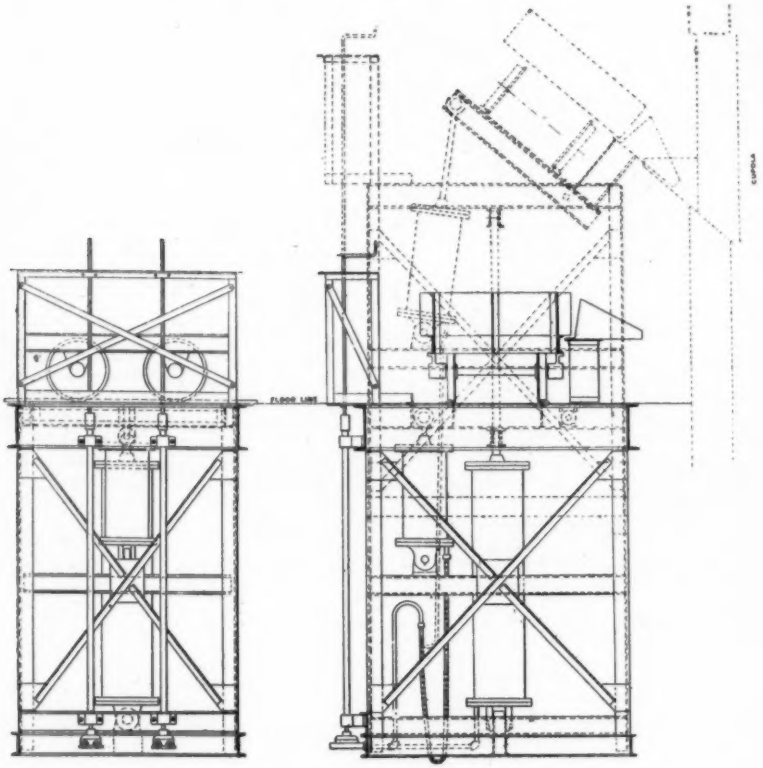


FIG. 3.—COMPOUND CHARGING MACHINE FOR FOUNDRY CUPOLAS.

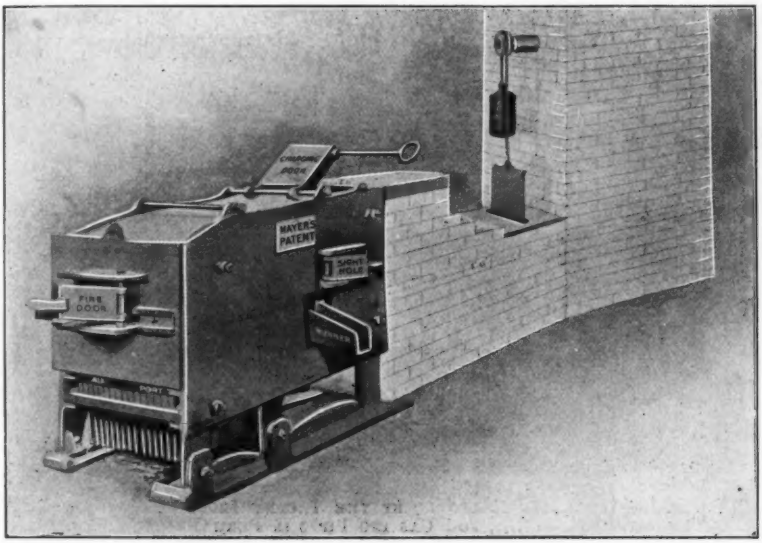
A BRASS MELTING AIR FURNACE.

THE illustration shows a Mayer's patent air furnace for melting brass in small quantities without the use of costly crucibles and coke. The furnace is fired with splint or hard coal, and consumes its own smoke. It is tapped after the manner of an ordinary foundry cupola, and the brass runs into the ladle in the same way. One cwt. of brass can be melted with ½ cwt. of coal, and the full capacity of the furnace is 3½ cwts. of metal at a heat. Six or more heats of that weight may be run per day, while smaller charges can be melted more rapidly. It is claimed that there is no waste of brass in charging and tapping, and that there is no brass ash to waste metal. Bronze and all kinds of borings may be melted. The makers state that the average loss when the furnace is melting Admiralty or gun-metal is 2 per cent., common bar or bush brass 3 per cent., side-light brass 4 per cent., and yellow brass 4 to 6 per cent.

The control of the furnace is by means of a damper, and the illustration shows one method of connecting up to the chimney and the position of the damper gear. They are portable, and substantially made, and are despatched from the works complete, ready for connecting, and can be placed on the top of crucible furnaces or in any place where a direct connection can be made to the chimney. The weight, when complete is about 2½ tons.

It is stated that these furnaces can be in constant use for upwards of six months without requiring to be rebuilt, they being built of best firebricks. A template of the internal part is supplied with each furnace for guidance in rebuilding, along with a set of firing and tapping tools.

While the illustration shows a left-hand, small standard 3½-cwt. furnace, they can be supplied in various sizes, and also right-handed, or if desired, to tap on both sides.



A "MAYER'S" BRASS MELTING FURNACE.

The makers are Messrs. Hardie & Gordon, Levenbank Foundry, Dumbarton, N.B.

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THE works of John Butler & Company, Limited, the Leeds Engineering and Hydraulic Company, Limited, J. Firth Blakeley, Sons & Company, Limited, and Bell Brothers, are all being driven electrically, the supply being taken from the mains of the Yorkshire Electric Power Company, Limited.

CAST IRON PIPE MADE IN PERMANENT MOULDS.*

By Edgar Alan Custer.

At the plant of the Tacony Iron Company, Philadelphia, soil, water, and gas pipes are cast in permanent cast-iron moulds, which the hottest iron attainable from the cupola does not destroy. Cast-iron pipe is produced in which the supposed evils of unequal heating and cooling not only do not appear, but do not exist. A machine, whereby the casting operations can be carried on continuously, completes the labour-saving equipment of this installation.

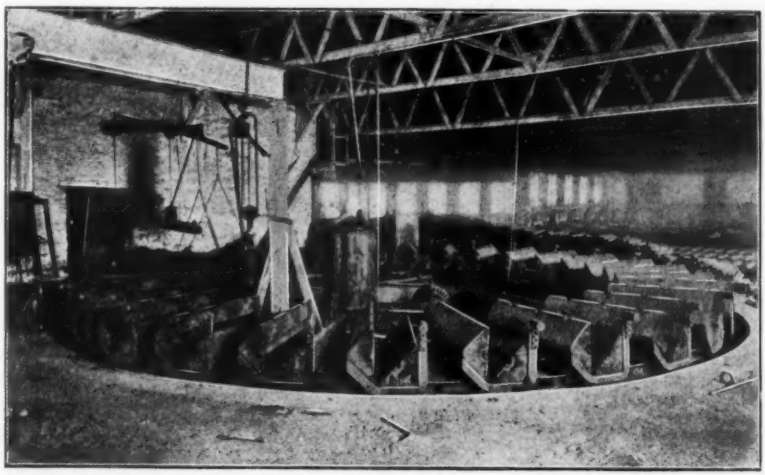


Fig. 1.—Apparatus Employed by the Tacony Iron Co., Tacony, Pennsylvania U.S.A., for Casting Pipes in Permanent Moulds.

So-called permanent moulds are not new. For many years small iron castings have been successfully made in iron moulds, and this without great detriment to either the casting or the mould. These castings, however, were invariably very small and were chilled to extreme hardness. Fortunately, it was not necessary to machine them. This limited the use of such moulds very materially. Some years ago the Latrobe Steel Company cast car couplers in iron moulds. Within a few months, an article has been published, describing a successful method of making brake shoes in this manner. These shoes weighed about 20 lbs. each, and with the exception of steel ingots and car couplers were the heaviest castings made in iron moulds. So far as can be learned, this is about the extent of the art. It has been the dream of every foundryman whose trade requires a large number of duplicate castings, to make these castings in moulds that would not only survive the process, but would also produce castings that would be marketable and easily machined.

Method of Making Ordinary Soil Pipe.

The method that will be described relates only to soil, water, or gas pipe. In the manufacture of soil pipe, iron flasks, cope, and drag are rammed with sand over a metal pattern; a green sand core is introduced, and the cope and drag are clamped together. The pipe is then poured, with the pipe in a horizontal position, and after cooling, the pipe is removed from the flask and carried to the end of the floor where the cores are removed. Then it is carried to the cleaning room where the sand is rattled off, the gates and fins are removed, and after inspection it is ready for shipment. Altogether the pipe has to be handled ten times. In this process the loss is very great. So much depends upon the condition of the sand; it may be too wet or too dry; the moulder may

* Paper read at the March meeting of the Franklin Institute, Philadelphia.

ram carelessly, or may pour his iron negligently so that the foundry loss often reaches 12 to 15 per cent. In summer weather the output is decreased 25 to 40 per cent., due to the inability of the workmen to endure the exacting and exhausting labour. Only one heat a day can be poured in any season. In fact, with very few improvements, and these relating mainly to making cores, we are making soil pipe in precisely the same manner and with just as much labour per pipe as was the practice 50 years ago.

It is true that the workman of to-day makes more pipe in one day than his grandfather did, but this is due more to the fact that the present-day workman is working piecework and has become infinitely more skilled in saving the seconds of time for each particular operation and avoiding the useless motions in per-

FIG. 2.—ORIGINAL FORM OF MOULD.

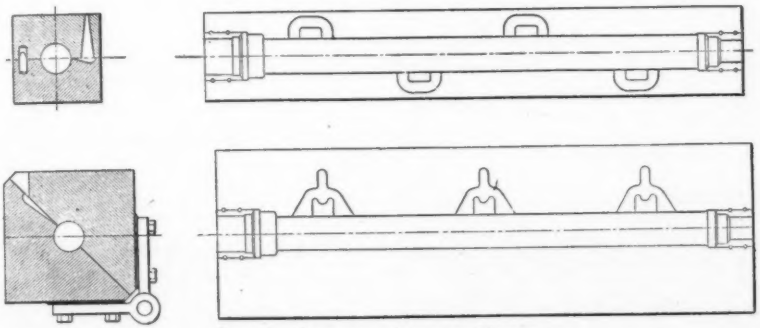


FIG. 3.—PRESENT FORM OF MOULD.

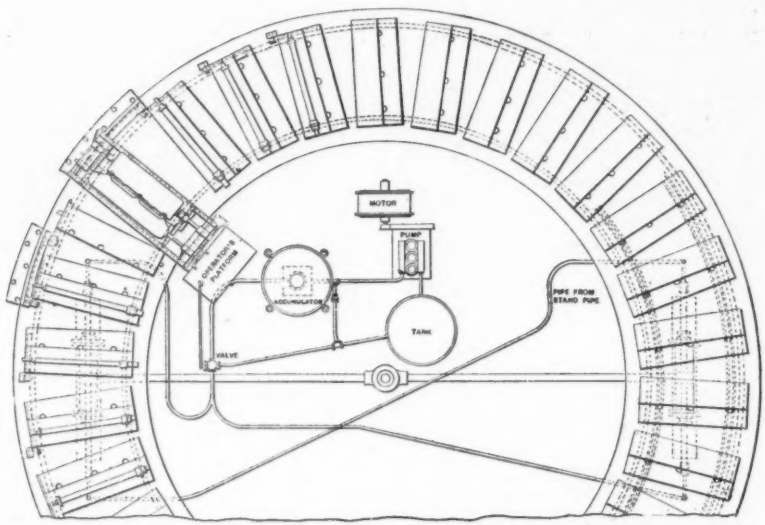


FIG. 4.—TABLE FOR PERMANENT MOULDS, SHOWING APPARATUS FOR ROTATION.

CAST IRON PIPES MADE IN PERMANENT MOULDS.

forming them. Any process that would save the use of sand for the mould and would produce pipe that could be easily cut would of necessity be very desirable. If in addition it would obviate cleaning and chipping, and could be run continuously night and day, it would very nearly meet the conditions of an ideal business.

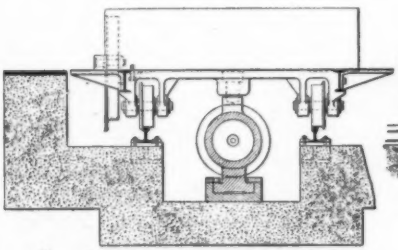


FIG. 5.—TABLE TRUCK, SHOWING DRIVING MECHANISM.

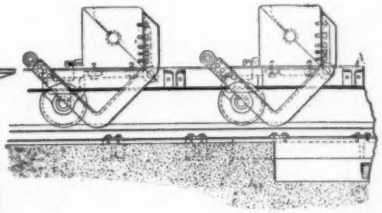
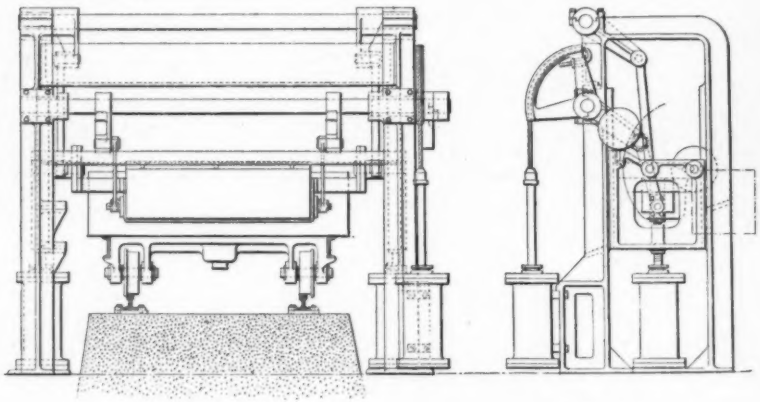


FIG. 6.—ARMS FOR OPENING AND CLOSING MOULDS.

Early Tests of Moulds.

When experiments to discover and perfect such a process were undertaken, the first mould made was closely modelled from the flasks in use in the sand process. In fact, all the traditions of foundry practice were closely followed. The apparent danger of pouring molten iron into iron moulds, encasing a damp sand core, was considered to be serious, and the problem of disposing of the resultant gases it was thought would prove to be a great one. Again, the pipes were less than ¼ in. thick, and it was necessary to pour the iron very quickly. So far as was known, no one had successfully poured a complete pipe in an iron mould, and such attempts that had been made had destroyed the mould very quickly. A mould 6 ft. long would be permanently warped in a short time, hence it is not surprising that the experiments were approached with considerable trepidation.



SIDE ELEVATION. END ELEVATION.

FIG. 8.—PRESENT FORM OF POURING APPARATUS.

CAST IRON PIPES MADE IN PERMANENT MOULDS.

The first mould made consisted of a cope and drag, each 6 ft. long, 10 in. wide, and 6 in. thick, with gates cut into the drag. This mould was cast of very soft iron and the pipe shape bored out.

The pouring holes were tapered so that when the cope was removed the iron in them could be easily knocked out. In order to avoid as far as possible all traces of moisture the mould was heated to 500 degrees Fahr., an ordinary green sand core was inserted and four men poured molten iron into the gates. These men wore goggles and were swathed completely in wet clothes. We did not then know what would happen. As it turned out, nothing happened, not even a semblance of pipe, the gates were too small. A short session with a hammer and chisel made them larger, and on the second attempt a complete pipe was poured. It was not a remarkable pipe except for its defects. It was streaked with cold shot, the top was filled with flat spots where the gases had been trapped, and it was as hard as flint. After an infinite number of experiments the mould now in use was evolved. A complete description of this mould as it appears on the machine will be given later. After 50 or 60 pipes had been cast in this mould, it became badly cracked around the gates, and as the process of casting was continued these cracks extended into the barrel of the mould. This we attempted to obviate by casting into a new mould very thin strips of mica, extending throughout the length of the mould and placed radially at intervals around the barrel or mould cavity. The cracks we found in this mould would start as before, but would stop when the mica was reached. A good illustration of this effect is shown by the fact that a small hole drilled at the extremity of a crack in a sheet of plate glass, immediately stops the further extension of the fracture. In time, the whole face of the mould would show a collection of fine cracks, most of which could only be seen with a magnifying glass. They rarely ever were more than $\frac{1}{16}$ in. deep.

After probably 200 pipes had been cast the surface of the mould in contact with the molten iron resembled an extremely hard graphite. It was dull black in colour but did not scale or shell off. In order to thoroughly test the mould, the ends were stopped up with sand and the entire barrel, without a core, was filled with molten iron. This was done thirty or forty times without any appreciable distortion of the outline. The only care

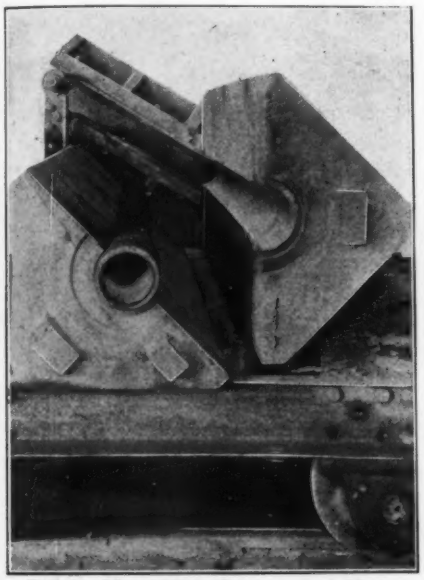


FIG. 7.—METHOD OF CLOSING THE MOULD.

FIG. 11.—CORE-SETTING.

CAST IRON PIPES MADE IN PERMANENT MOULDS.

exercised was to take the casting out before heavy shrinkage set in. In order to still further test it, the mould was heated to a temperature of about 1,100 degrees Fahr. in a furnace, but it was found impossible to produce pipe under these conditions. The molten iron danced in the mould like water on a hot griddle, and the resultant pipe was a collection of closely-knit globules. It was found that the safe casting heat of the mould was about 700 degrees Fahr., but that in practical operations 250 degrees Fahr. to 400 degrees Fahr. was the highest heat the moulds reached. The actual time in over and above the first cracking as described before; in fact, they are in a far better condition than at the start. Each one has been purposely abused and submitted to treatment that never occurs in practice. A straight-edge laid in the barrel to-day shows the surface straight, and the 4,600 pipes show the original marks of the boring out tool.

Silicon and Sulphur Content of Metal.

It was found that an iron running from 2.00 to 2.25 per cent. silicon and high in carbon produced the greatest

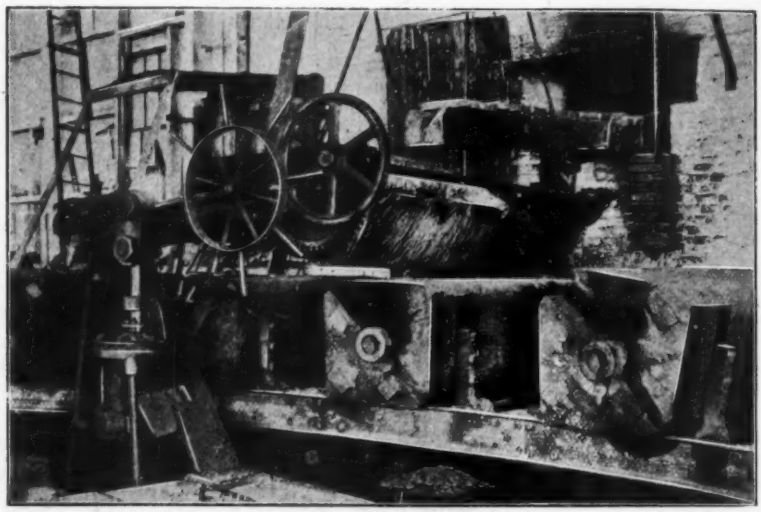


FIG. 9.—ORIGINAL FORM OF POURING APPARATUS.

CAST IRON PIPES MADE IN PERMANENT MOULDS.

which the metal set was carefully noted, and the behaviour of the cast metal at extremely high temperatures was observed.

Experiments with Different Grades of Iron.

Irons high and low in silicon, sulphur, carbon, and phosphorus were cast a great many times and copious notes were taken in each case. A small chemical laboratory was established for this work. In all over 4,600 pipes were cast in a 4-in. pipe mould, 2,700 in a 2-in. mould, and over 1,100 in a 6-in. mould. Not one of these moulds show any signs of deterioration number of perfect pipes, and when cast iron of this silicon had a comparatively low sulphur content, the result was still better. Further experiments showed that powdered ferro-manganese, when added to the molten iron, immediately combined with the sulphur as a manganese sulphide, and rose to the top of the liquid mass as a slag. An excess of manganese, however, produced a hardening effect, as it formed with the carbon, a carbide which in itself is an extremely hard substance. These features made is possible to use a high sulphur cast iron, providing its other contents approximated to the figures given above.

Temperature Experiments.

It was then noted that pipes that remained in the mould until a dull red heat was reached were very hard, and in most cases were too hard to cut. When they were taken out at a bright yellow heat and allowed to cool normally they were perfect in texture. It was further noticed that when the dull red pipes were piled with the very hot bright yellow pipes, an annealing process was set up that brought the iron in the dull red pipes into a workable condition. This feature softener of cast iron, depends principally upon the rate of cooling. If molten iron high in carbon be cooled slowly, the free carbon separates out in the form of graphitic carbon. If this molten iron be suddenly cooled, the carbon is caught before it has time to separate and is held in an atomic condition by the enormous pressure of the surrounding iron. Therefore, the fracture of a pig of iron is generally an index of the rate at which it is cooled. If the suddenly cooled iron be re-melted and slowly cooled, it will

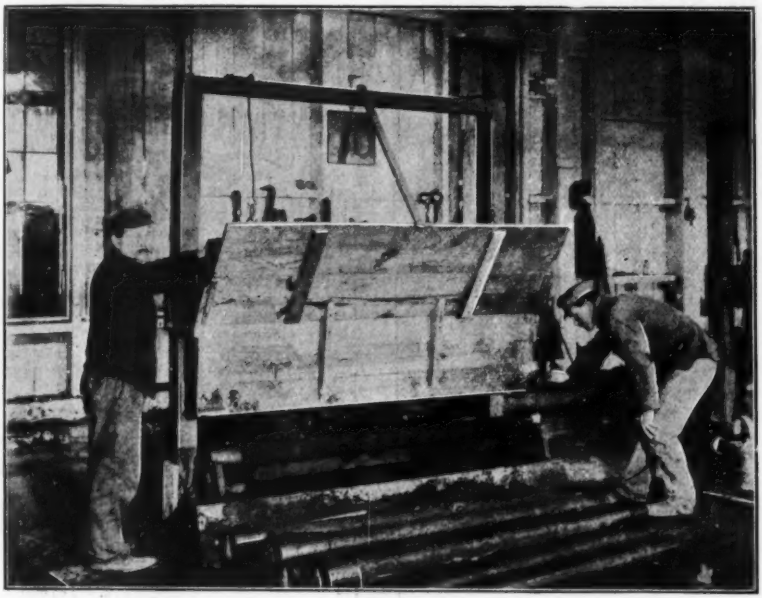


FIG. 10.—CORE-MAKING.

CAST IRON PIPES MADE IN PERMANENT MOULDS.

of temperature was the subject of a long and patient investigation, and the causes leading thereto may be now briefly stated.

Pure iron possesses no fluidity or the property of low shrinkage, nor does it possess varying degrees of hardness. It is obvious then that the characteristics of cast iron, which possesses these qualities in a high degree, are due to the presence of impurities, such as carbon, silicon, phosphorus, etc. Carbon is the main element, and exists in cast iron as combined and free carbon. The amount of free carbon, which is the principal assume all the characteristics of soft iron. The graphitic carbon will become plainly separated and large crystals will be formed. It may be stated that cast iron in a molten state is a solution of carbon and iron, and the mass is homogeneous.

Silicon in itself confers no benefit on cast iron. It is only its influence on the carbon contents that produces beneficial results. On the other hand, an excess of silicon renders cast iron absolutely unfit for use, making it very hard and brittle. A small quantity through its action on the carbon, reduces shrinkage,

increases strength, and increases fluidity. Given then cast iron comparatively high in carbon with the proper amount of silicon the ideal conditions are obtained.

The uses of phosphorus and manganese are too well known to require discussion, and play no part in this method except as correctives.

Keeping these facts in mind it may be stated that an ordinary foundry iron very nearly fulfills these conditions, with the exception of sulphur. Molten cast iron is, therefore, a solution of carbon

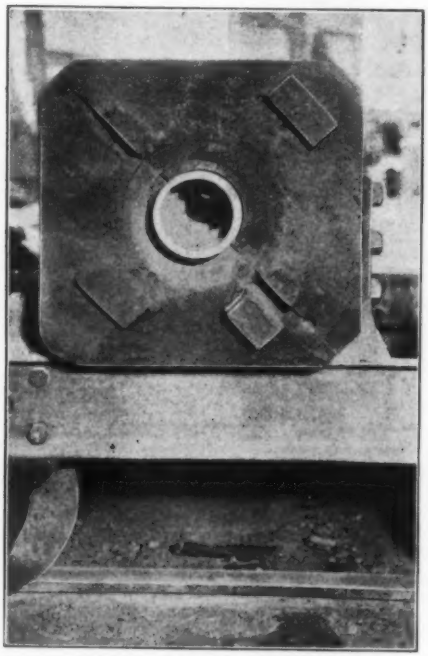


FIG. 12.—A CLOSED MOULD.
CAST IRON PIPES MADE IN PERMANENT MOULDS.

in iron with the addition of silicon, phosphorus, sulphur, and manganese, all forming a homogeneous fluid mass. Now, if this mass be suddenly cooled, it is still homogeneous, the different elements not having time to segregate. If the cooling be continued at the same rapid rate until a temperature of about 1,600 degrees Fahr. is reached, the iron becomes very hard and brittle. But if this sudden cooling is carried out only until the iron is set, and is then removed from the cooling influences, thus allowing the iron to lose its heat normally, the result is a structure whose fracture shows a very fine close grain. It is tough, since all its particles are thoroughly interlaced, and it is strong because very nearly all the carbon is held in the combined state. In other words, it is homogeneous. Now, let us try to make this vital point plainer.

Rate of Cooling.

In a casting, such as a thin pipe, when cast in an ordinary sand mould, it requires about one minute to cool from the temperature of molten iron to the point at which the metal is set. It is in this period that the detrimental effects as shown in cold cast iron are produced. Phosphorus, sulphur, and carbon segregate, and graphitic carbon is formed. Bear in mind that in this period the iron is in a liquid state with all its elements free to move. We may call this the evil period. Once the casting is set, all segregation ceases, and the remaining carbon begins its beneficent work. As the iron loses its heat at a normal rate, annealing and carbide carbon are formed, both of which improve the quality of the metal. Consequently, we can call this the beneficent period. Now, if we suddenly shoot the molten iron into an iron mould it sets very quickly and the evil period is reduced in time from 60 seconds to 2 seconds—so short a time, in fact, that all the impurities are held in the position they occupied in the molten mass. The evils of sulphur and phosphorus are reduced to a minimum since they are in practically an atomic condition, and are distributed evenly throughout the casting; and since no graphitic carbon is formed, all the carbon exists as combined carbon, with a corresponding increase in its power for improvement. If the casting, after it has passed the evil period, is removed from the cooling influence, in this case the iron mould, and allowed to cool normally, the ideal conditions are obtained.

Chilling cast iron to the point of extreme hardness is purely a mechanical process, and the point to which the process of sudden cooling can be carried can be determined to an absolute certainty. It is simply a question of time. The data collected show that a 2-in. pipe can be removed 2 seconds after pouring, and should not remain in the mould more than 6 seconds. A 6-in. pipe can be removed in 6 seconds after pouring and should not remain more than 12 seconds. This time depends upon the thickness of the pipe walls. Very thin pipe would

require not only a shorter time in the mould, but should be cast of iron higher in silicon. The reason for this is that silicon by its action on the carbon keeps the iron in a fluid state longer than normal. Every foundryman knows there are irons in which it is impossible to produce a chill, and there are others in which it is impossible to prevent it. The same limitations apply to making pipe as to the making of other iron products. A suitable iron must be provided if the very best results are to be obtained. This statement applies to any branch of the foundry business, and is not set out as a new discovery. What is claimed and demonstrated is, that a poor iron is improved and rendered suitable for the work in hand.

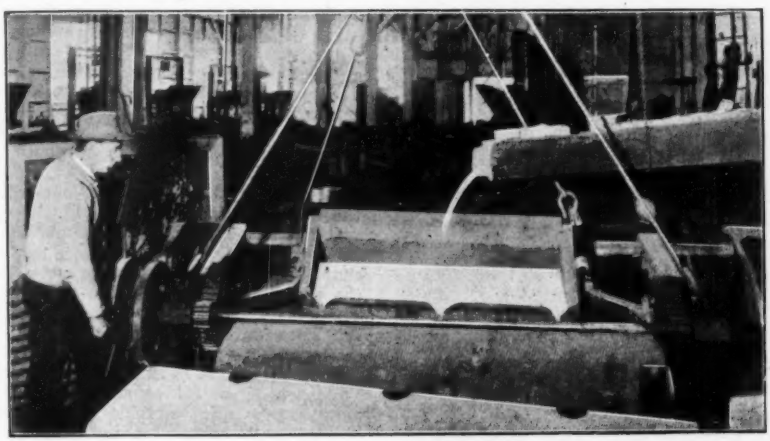


FIG. 13.—POURING A PIPE.

CAST IRON PIPES MADE IN PERMANENT MOULDS.

Continuous Pipe Casting Machine.

With the data obtained the work of designing a machine that would operate continuously was begun. The experiments had shown that when pipes were cast in a mould every 8 minutes, the temperature of the mould never rose above 450 degrees Fahr., even if the operation were continued for hours. If pipes were poured every 2 minutes, the temperature of the mould rose rapidly, and at 900 degrees Fahr. it began to warp. In order to follow the best conditions and avoid the worst, this apparatus was designed.

The machine, Fig. 1, consists of an annular table or ring, approximately 40 ft. outside diameter, carrying 30 moulds, arranged at equal intervals thereon. The table is constructed of two concentric rings of channel beams, connected with 30 cross pieces or trucks, each of which has two wheels having roller bearing axles. These wheels are arranged to run on concentric circular tracks set in concrete foundations. The tracks are arranged as if on the surface of a cone, and by this means is created a tendency of the table to resist any movement other than rotating about its centre. Either outer or inner track may be the higher, as the effect is the same in either case.

Each truck or cross bar of the table carries a steel pin working loosely in a vertical hole, and of such length as to allow about 2 in. of pin to project below bottom line of truck, but admitting of being pushed up until flush with bottom of truck.

Under the table or ring, at two diametrically opposite points, are arranged two hydraulic cylinders which slide in ways similar to a planing table, the pistons within the cylinders being held stationary and the cylinder moved back and forth by the operation of a four-way valve controlling the admission of water, alternately to each end of the cylinders. The stroke of the cylinders

is of such length as to be slightly more than the spacing of moulds carried by the table, and projecting from the top of cylinder is an inclined plane surface designed to lift the pins in the trucks when the cylinders move in a direction opposite to the required motion of the table, and to allow a pin on each side to fall after the inclined surface has passed. This occurs at or near the end of the backward stroke of the cylinders, and when the controlling valve is so moved as to cause the cylinders to move forward, the pins which have been lifted and allowed to fall are brought in contact with the projections on the cylinders, and

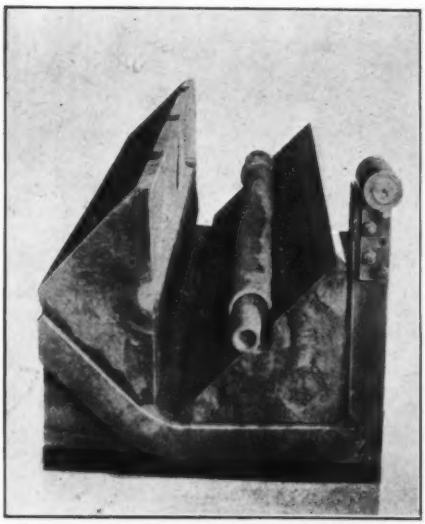


FIG. 14.—FINISHED PIPE IN THE MOULD.

CAST IRON PIPES MADE IN PERMANENT MOULDS.

hence the table is carried forward by the motion of the cylinders a distance equal to the spacing of the moulds, and the cylinders are ready for another return or back stroke to engage the next pins, thus intermittently moving the table ahead one space, at each cycle of the cylinders.

The centre of the table is left open for the location of hydraulic pumps, operating valve reservoirs, etc., required in imparting motion to the table. This table makes one complete revolution every 7½ minutes, and consequently produces 30 pipes in that time, or 240 pipes per hour.

At certain points about the table are arranged closing and opening devices, Fig. 7, which are designed to close the mould, or bring the cope side down to its place on the drag side, without shock, after the cores are set in place, and to open the mould or lift the cope after the pipe has been poured.

Between the closing device and the opening device is located a pouring device, Figs. 8 and 9, to receive the molten metal from the cupola and pour it into the moulds.

Each mould consists of a rectangular block of cast iron, approximately 18 in. wide and 18 in. high, by 6 ft. long, parted on a diagonal line across the corners, and provided with hinges at the lower edge of the parting so as to allow the upper portion or cope to be swung up and back from the lower portion or drag. These moulds weigh about 6,500 lbs. complete.

At the centre of the mould is the cavity into which the metal is to be poured, to form the pipe. Thus one-half of the pipe is formed in the upper and one-half in the lower portion of the mould.

Gates are cut in the face portion of the lower part or drag of such a size and shape as to receive the molten metal from the ladle and guide it into the mould. Three such gates are used, each dividing into two portions and so entering the cavity of the mould at six points.

These gates are so shaped as to receive the shock of the falling stream of molten metal at a point outside of the mould cavity, and convey it into the mould quickly but gently so that the core is not damaged by a rush of molten metal against it.

At the highest point of the barrel of the mould a small groove is cut, extending throughout the entire length of the barrel. This groove, which is quite small, being only ⅛ in. wide and deep, is intended to receive any gases or air which may be trapped in the mould, and so avoid the formation of flat spots at the top of the pipe. The resultant ridge not being prominent is not an objection but rather adds to the strength of the structure.

On one end of each mould is carried an arm rigidly attached to the upper or movable half. This arm extends under the mould and is of such form that when the mould is open, it forms a rest for the movable half, holding it in such position as to allow of any work, such as getting cores, removing finished pipes, cleaning, etc. On the end of this arm is

a steel roller which is caused to travel down an inclined plane by the rotation of the table carrying the mould. This inclined plane is arranged to receive the roller at its higher position when the mould is open, and to guide it smoothly to its lower position, by this means closing the mould without shock or jar to disturb the core. This inclined plane constitutes the closing device.

Each end of the mould is provided with rings or bushings which are used to support the core arbour in a precisely central position in the cavity of the mould, so that the pipe when finished shall have uniform thickness of metal at every point.

The core arbour consists of a cast-iron hollow cylinder somewhat longer than the pipe to be cast and about $\frac{3}{4}$ in. less in diameter than the inside diameter of the pipe. It is perforated throughout most of its length by small holes, to allow any gases formed by contact with the molten metal to pass into the arbour and so have free vent to the air through the ends of same. Each end of the arbour is accurately machined to fit the rings or bushings in the ends of the moulds.

Core Making.

The core is made by placing the core arbour in the core machine, which consists of a support for the ends of the arbour, semi-circular in form, and of a diameter to fit the arbour ends; a shaking screen arranged to sift sand, and a guide to drop it upon the arbour, and a knife, so shaped as to form the sand to the outline of the inside of the pipe.

The core arbour after being wet thoroughly is placed in the end supports, and rotated by a crank-shaped piece of iron held loosely in one end by an operator. At the same time another operator shakes a sieve suspended over the arbour and previously filled with sand, tempered to the proper degree with water. This sieved sand is caused to fall directly upon the wet, rotating arbour and clings to it. The surplus sand is scraped away by a steel knife held at the proper distance from the arbour to make the finished core of the diameter and shape required. When sufficient sand is on the arbour to make a full and complete core (which requires about five seconds), the core is lifted from its supports, and is ready for use. No further treatment of any kind is needed, and the core is placed in position in the mould, which is then caused to pass the closing device, bringing the upper portion down in place, and the mould is ready to receive the metal.

Method of Casting.

A ladle is provided to receive the metal as it flows from the cupola. This ladle is arranged so that it can take a position high enough to allow the moulds to pass freely under it, or it can be lowered into a position between two adjacent moulds so that the pouring spouts or lips of the ladle are very close to the pouring holes of the mould.

As the table rotates and brings a mould, which has passed the closing device, into pouring position, the ladle automatically drops into this latter position with the lips close to the pouring holes. The ladle is then tilted to pour by the operator, but in tilting it rotates around a centre line which passes through the pouring lips, and hence the points of pouring do not move; and the streams of metal are guided directly into the pouring holes through the various gates, into the mould, and fill it completely, compressing any air or gas which may be trapped into the groove provided at the highest point for that purpose. If no gases are trapped, which, strange as it may seem, is usually the case, this groove is also filled with metal and forms a slight rib running the length of the pipe.

When the pouring operation is complete and the operator tilts the ladle back, it automatically rises to its higher position, so that the next mould may pass under it and assume the pouring position.

The mould, being now filled with metal, is held long enough to allow the metal to set enough to hold together, and then opened by passing the opening device, which is just the reverse of the closing device; the roller on the end of arm or mould being guided up an inclined plane, thereby lifting the upper half of cope side and swinging it away from the lower or drag side.

The pipe, which is still a bright orange colour, is lifted from the mould and placed, after removal of gates, with those previously cast, in piles, to cool slowly, when the core arbour is withdrawn and returned to core machines to be used again.

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Professor McWilliam, of Sheffield University, recently lectured before the Sheffield Branch of the British Foundrymen's Association on "The Properties of Steel Castings."

THE CALUMET CUPOLA.

THE conspicuous feature of the new cupola that is being built by the Calumet Engineering Works, Harvey, Ill., is the location of the air chamber inside of the furnace shell. This construction increases the thickness of the lining at the melting point just above the tuyeres, thus preventing the burning of the shell due to the destruction of the lining at this point. By placing the shell on the outside it is also easily inspected at the bottom. The inside plate of the air chamber is removable, and may be replaced when burned out. As shown in Fig. 1, the conical shape of the furnace results in an enlarged base. A cross section of the cupola is shown in Fig. 2. The two blast inlets are located at either side to insure an equal distribution of air in the cupola. They may be attached to suit the location of the furnace. The tuyeres are of the rectangular expanded type, properly proportioned to the blower outlet of any standard machine, and provide a nearly continuous blast opening inside the furnace. The upper tuyeres provide an additional air supply to complete combustion, and are provided with dampers for closing them if desired. A safety tuyere is provided near the slag spout, which prevents the molten iron from rising and flowing through the lower tuyeres. The shell and stack are of steel plate construction rivetted in sections. Angle lining supports are rivetted to the shell at intervals, and standard fire-brick can be used for the lining.

The cupola rests on a heavy cast iron flanged base ring to which the furnace shell is bolted on the outside, and the removable air chamber is built on the inside. The cast ring rests upon ribbed columns which stand upon cast base plates held together with steel rods.

The columns are curved to allow the bottom doors to swing back free of the door. Clean out doors are provided in the air chamber, and are machined to insure a perfect fit. The spouts enter the furnace through cast iron frames in the air chamber bolted to the shell. The slag spout is adjustable to conform to the height of the tuyeres. The furnaces are built in eleven sizes, ranging from 24 to 84 in. in diameter inside of the lining.—"Iron Trade Review."

FIG. 1.—THE "CALUMET" CUPOLA.

THE RISE AND DEVELOPMENT OF THE BRASS TRADE.

THE first of a series of lectures on "Brass" was delivered on April 28 by Professor Thomas Turner in the large Medical Lecture Theatre of the University of Birmingham. In giving a brief account of the history of brass, Professor Turner pointed out that the development of the metallurgic arts is an index of the civilisation and prosperity of a nation. The stone tools and weapons of early man were of three distinct periods, and stretched back into remote antiquity. The discovery of copper was the next stage in most cases, and the use of this metal hardened in various ways, and in later years particularly by the addition of tin, led to the spread of the bronze age over a great part of Europe, Asia, and parts of Northern Africa. In many parts of the world, however, no evidence of a separate bronze age could be traced, but iron and bronze were used side by side. In Egypt, in particular, bronze was found among the earliest remains, and recent researches had tended to thrust back farther and farther the dawn of the bronze age. The skill of the Hindus and Japanese in bronze castings called for special recognition. In the Middle Ages Germany was renowned for brass, and particularly for church brasses, over 4,000 of which are known to exist in this country. Most of them came from Nuremberg, which still has a fairly considerable trade in metals. The manufacture of brass is believed to have been introduced into England in 1565, while brass works, which are still in existence, were started in Bristol about 1702. Brass was first made in Birmingham, about 1740, works being erected in Coleshill Street about that time by Turner. When Queen Victoria ascended the throne there were about 175 brass works in Birmingham, with an average of less than twenty employés in each. There are now over 800 establishments in the local brass trade, with an average of nearly fifty employés in each.

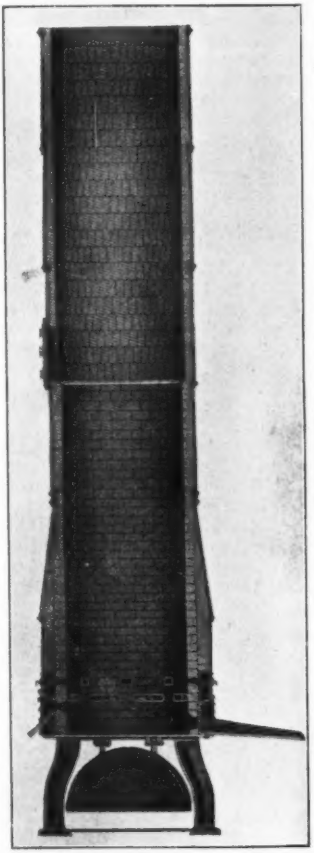


FIG 2.—SECTION OF THE "CALUMET" CUPOLA.

Turning to the subject of the metallurgy of copper, the lecturer pointed out that in commerce there are three well-recognised kinds of the finished material, namely, conductivity copper, which is specially pure; best select, which is used for alloys, and which is of very considerable purity, though not so markedly so as the former; and wrought copper, to which appreciable quantities of arsenic, iron, or other elements are added in order to improve its durability or working qualities. The rest of the lecture was an illustrated description of the production and refining of copper by modern methods.

CORRESPONDENCE AND QUERIES.

SAND.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—We are requiring for a special purpose of ours a clean quartz sand, either white or yellow, and of medium coarseness in grade. We have tried several of the well known pits in this country, but have been unable to obtain a suitable quality. Could you give us

the names of any pits in this country where a quartz sand is obtainable.

Yours, etc.,
C. R. T.

MELTING STEEL FOR MILD STEEL CASTINGS.

To the Editor of the FOUNDRY TRADE JOURNAL.

In reply to "B. S. S.," steel will melt very well without any flux at all, and the practice has been discontinued many years. It requires good, hard coke, and a proper furnace to melt steel. Mild steel requires the greatest heat, and the most time, and should be done while the pots are in good condition. The following methods are generally adopted for melting steel. Each pot requires a stand and a lid. In form, the stand is the frustum of a cone about 3 in. high, and as upon the base of the stand the pot is to rest, they should correspond in size. The stands are made of common fireclay. The lid should be of clay, the same as the pot, and a little larger in diameter, flat on the underside, and a little convex on the upper. The stand is placed in the proper position upon the grate bars, and upon the stand the pot, covered with its lid. Some fire, with a little coal, and soon after some coke, is put on, and when this has burnt up, sufficient coke to cover the pot. When the furnace and pot are at a white heat, the steel may be put in. To charge the pot the lid is taken off, the steel is gently thrown in, in the best position for making the pot hold the charge. The lid is then replaced, the furnace is filled with coke, and the cover put down afterwards, as the fire requires more coke. The man in charge should be able to judge how much coke should be put into the furnace to obtain the desired result. Before the steel is well melted it appears to be in a state of ebullition, but when it is ready—which is known by its clear surface and its resting in the pot without motion, and resembling in its dazzling brilliancy the sun on a clear day more than anything else—it is time to take it out.—C. E. Allen.

POTS FOR MELTING STEEL.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Can you inform me what kind of clay is used for making pots for melting steel, and, also, the method of making same? Thanking you in anticipation.

Yours, etc.
"CLAY."

CHILLS FOR ANTI-FRICTION METAL.

To the Editor of the FOUNDRY TRADE JOURNAL.

In reply to "N. H. C.," I am not conversant with any firms who make a speciality of chill moulds for anti-friction metals. Most vendors of such metals have their own private patterns for such, and if they have not an iron foundry attached, they send their patterns out to a suitable jobbing foundry when they require new moulds. This would be the best and simplest course for "N.H.C." to adopt.—C. E. Allen.

PHOSPHOR-BRONZE.

To the Editor of the FOUNDRY TRADE JOURNAL.

"E. M. B." will find the two following mixtures of great value for the rings that he wishes to make:—(1) Copper, 84 lbs.; phosphor tin, 12 lbs. (2) Copper 63¾ lbs.; phosphor tin, 12¾ lbs. These mixtures should be melted and run into ingots first, and then re-melted for casting. Should he desire them harder, add the following when re-melting to the above quantities:—Common tin, 2 lbs.; phosphor tin, 1 lb.; and zinc, 1 lb. But in themselves the above mixtures are of great strength, and have to meet the requirements of the Home and Foreign Governments. The phosphor tin is added to the molten copper in the same manner as common tin, and the mixtures stirred. The melting point of phosphor is 400 to 500 degrees Centigrade, and the phosphor alloys are very thin when melted, so sand moulds should be very dry, poured quickly, and in as large a stream as possible.—C. E. Allen.

BRASS MIXTURE FOR OPTICIANS' WORK.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Will you help me out of a great difficulty? I am being hard pressed by my master on account of my inferior brass. Can you give me a mixture that will do for opticians' work? It is very particular; he wants his castings turned out of the mould with a bright red colour. Would a small amount of lead give the desired result? The work being very fine, requires a very good mixture, I should esteem it a great favour if you could help me. I have often noticed accounts of fellow moulders in the same difficulty as myself, but instead of saving the answers I have destroyed them.

Yours, etc.,
"A BRASS MOULDER."

LIST OF NEW INVENTIONS.

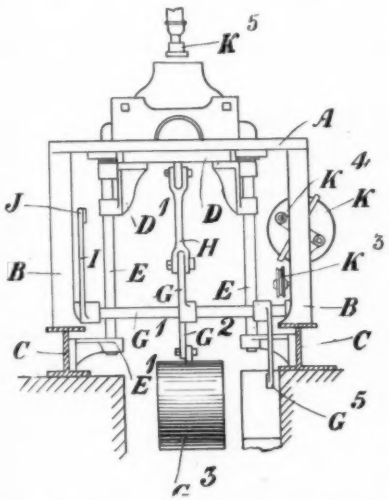
6,037. L. Hirt. Improvements in or relating to dividing blocks for centrifugal machines.

6,462. M. Winterbauer, C. Kneffel, Jun., and R. Wachwitz. Improvements relating to the alloying of steel or iron surfaces.

6,851. Oakley Steel Foundry, 1907, Limited, and E. Buchholtz. Improvements in or connected with liquid fuel burner devices for steam boiler furnaces and other furnaces.

6,694. E. Hall, Poulton le Tylde.

This invention relates to moulding machines or appliances for use in preparing moulds for the casting of mill and



other pillars, uprights, columns, and such like articles as are capable of being moulded from a half-pattern or repetition pattern and also to apparatus requisite in preparing moulds.

According to this invention the mould is made on a table or bedplate, and the pattern is mechanically introduced preferably from below, after which the sand is rammed down, preferably by a pneumatic ram.

The figure shows one of the mould tables and the position of the ram with a half-pattern mill pillar thrust up.

In carrying out this invention a table A for the moulding flasks, or half-flasks, is used; this is suitably supported by the uprights B B which are stepped into girders C C. The table A is cut out to act as a stripper plate or surface through which the half-pattern can be protruded from below.

The aperture in the stripper plate or table may, and preferably does, coincide with the shape or the half-pattern which is laid on and secured to a rising and filling pattern carrier or platform D, and which has brackets such as D^1, the shaped extensions of which engage and slide on uprights E standing vertically between and secured to the lower face of the stripper plate A and brackets E attached to the girders C C. Hinged or movable catches are arranged to lock the pattern carrier.

The pattern carrier D is raised and lowered by mechanical means.

Bell crank levers G are mounted on short cross shafts G^1, the one arm G of each lever is joined up to the pattern carrier D by a link H, whilst the other arms G^2 each carry counter weights G^3.

To the cross shafts G^1 lever arms I are attached, and these are all coupled by connecting rods J capable of adjustment.

The patterns are thus raised or lowered by rocking the cross shafts G^1.

The ram K^5 is indicated in position above the pattern and the part K is an air cylinder which actuates guide rods K^4 and thus by a flexible tie over the pulley K^6 is made to actuate the pattern through the link G^5.

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The Lash Steel Process. — The Canadian Lash Steel Process Company, Limited, an Ontario organisation, has just about completed, and will shortly have in operation an electric furnace for the making of soft steel. The Company has purchased a building at Niagara Falls, and is installing therein a fully equipped steel plant, to be operated in connection with a 1,000-h.p. Héroult furnace, for the purpose of making steel by the Lash process. The supervision of the plant is under the direction of Messrs. Fitzgerald & Bennie, of Niagara Falls, and Robert Turnbull, of St. Catharines, Ontario, the Canadian representative of Dr. Héroult. Arrangements are being made with two leading metallurgical and electrical experts, one from England, and one from the States, to examine the process and make a full report. These experts will have every facility afforded them to watch the operations, as the plant is being completed, with its laboratories, cranes, casting pits, etc., so as to operate night and day at a capacity of from 25 to 30 tons of steel daily.

TRADE TALK.

THE RIO TINTO COMPANY, LIMITED, have removed to 3, Lombard Street, London, E.C.

MR. E. SCHMATOLLA has opened an office at Southampton House, 317, High Holborn, London, W.C.

MESSRS. A. A. PARK and A. H. DUFFIELD, engineers, Slough, Bucks, have been adjudged bankrupts.

MR. W. GREEN, Waterloo Road Engineering Works, Clitheroe, has decided to relinquish his business.

MESSRS. NICHOLLS & REYNOLDS have removed to King's Court, Broadway, Westminster, London, S.W.

MESSRS. ROBINSON & COOK'S iron foundry, St. Helens, has been temporarily closed owing to depression in trade.

MESSRS. ESTLER BROTHERS, Laurence Pountney Lane, London, E.C., have removed to 3, Cross Lane, Eastcheap, E.C.

MR. J. PRICE has opened an office at Queen Anne's Chambers, Broadway, Westminster, S.W., as a consulting engineer.

THE new "Eron" projectile of Hadfield's Steel Foundry Company, Limited, Sheffield, has been adopted by the British Government.

MR. E. C. AMOS, 22, Walbrook, London, E.C., has been appointed sole London and district agent for Wright & Wood, Limited, of Halifax.

MR. S. S. WHITELEY, engineer, has removed from the Eglinton Works, Garden Street, Nottingham, to Eglinton Works, Isandula Road, Nottingham.

THE business of the Mersey Engine and Producer Company, Limited, of Liverpool, has been acquired by the Power Gas Corporation Company, Limited.

A FIRST and final dividend of 4½d. in the £ has been paid in connection with the voluntary winding-up of the Hercules Engineering Company, Limited.

R. B. TENNENT, LIMITED, of Whifflet, Coatbridge, are having additional works erected for the manufacture of their numerous engineering specialities.

MESSRS. HALL, JUNR., R. HALL, and W. Y. HALL, Laurie Street, Leith, engineers, etc., have dissolved partnership, so far as regards Mr. R. Hall, Jun.

THE PHŒNIX AXLE COMPANY, Phœnix Works, Wednesbury, have appointed Mr. E. Swain, Bassishaw House, Basinghall Street, E.C., as their London agent.

MR. G. E. GORFIELD, 119, Finsbury Pavement, E.C., has been appointed trustee in connection with the affairs of Mr. P. J. Mallmann, a London consulting engineer.

THE NEVILE ENGINEERING COMPANY, LIMITED, of Worcester, have acquired the business of Messrs. William Sprowson & Company, of Newton Heath, Manchester, London, and Glasgow.

A DISSOLUTION of partnership is notified in connection with Messrs. J. Hart and J. L. Sampson, North London Iron Works, Wenlock Road, City Road, engineers and ironfounders.

MESSRS. J. A. PHILLIPS & COMPANY, cycle component manufacturers, are transferring their works from Bath Street, Birmingham, to the Credenda Works, Bridge Street, Smethwick.

MR. P. F. BRITTAIN, 110, Cannon Street, London, E.C., has been appointed the sole agent in England, Wales, and Ireland for the Universal Electrical Manufacturing Company.

MR. S. B. GRIFFITH, 8, John Street, Adelphi, Strand, London, W.C., has been appointed sole representative for the sale of the "Heyland" single-phase induction motor in Great Britain and the Colonies.

THE SECRET COMMISSIONS AND BRIBERY PREVENTION LEAGUE has now received its certificate of incorporation, and a public meeting in furtherance of the objects of the League will shortly be held in London.

COCHRANE & COMPANY, LIMITED, of Dudley, are supplying 14½ miles of 7-in., 6-in., 4-in., 3-in., and 2-in. cast-iron pipes, and special castings, to the Dawley Urban District Council, at a cost of £3,675.

MESSRS. W. N. DUDLEY and C. J. WASHBOURNE, manufacturers and factors of brass and iron castings and stampings, etc., Birmingham, trading as E. Brown & Company, have dissolved partnership.

THE BLAKE BOILER, WAGON AND ENGINEERING COMPANY, LIMITED, of Darlington, have just lately been awarded the contract for 325 40-ton all-steel bogie wagons for service over the Buenos Ayres Western Railway.

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, have during the month invited subscriptions of 98 per cent. for £250,000 (part of a total authorised issue of £300,000) 6 per cent. prior lien debentures in 2,500 debentures of £100 each to bearer.

THE creditors of Bruce, Peebles & Company, Limited, have appointed a committee to consider a scheme of reconstruction. By the scheme, trade creditors will, it is stated, receive 7s. 6d. in the £ in redeemable debentures, and 12s. 6d. in 6 per cent. cumulative preference shares.

MR. H. BLOODWORTH, representative of the Adams Manufacturing Company, will in future represent the London branch of Siemens Brothers' Dynamo Works, Limited, 1, Abchurch Yard, Cannon Street, E.C. This company have opened a new branch at Foster's Buildings, 22, High Street, Sheffield.

THE CALEDONIA MOTIVE POWER SUPPLY COMPANY, LIMITED, have removed their registered office to Parkhead Forge, Glasgow. The company are not now carrying on business at Leith, but arrangements have been made whereby the engines, formerly constructed there, will be manufactured by William Beardmore & Company, Limited, Dalmuir.

THE following companies are in course of being wound-up voluntarily:—The Newall Engineering Company, Limited; the Northern Machine Screws, Limited; the Union Iron Works Company, Limited; the New Engine Syndicate Company, Limited (liquidator, Mr. J. M. Hart, 101, St. Vincent Street, Glasgow); the Excelsior Engineering Company, Limited (liquidator, Mr. J. S. Dudbridge, 8, Lansdown, Stroud); and the Britannia Stamping Company, Limited.

MESSRS G. C. SAMUEL & H. ASTBURY have opened offices at 43, International Exchange, Edmund Street, Birmingham, where they will act as Midland representatives for Dixon & Son, Limited, Leeds (valves, steam fittings, etc.); the Haste Pump Company, Limited, Manchester (condensing plant, etc.); the Midland Manufacturing Company, Limited, Sheffield (railway and engineers' tools); and the Weldless Chains, Limited, Gartsherrie, N.B. (chains and slings).

PROFESSOR CARPENTER, of the Manchester University, who agreed to act as honorary secretary of the Representative Committee of leading metal traders, engineers, and metallurgists, formed to make the arrangements for founding the proposed Institute of Metals, has been indisposed. During his indisposition, correspondence in connection with the scheme has been undertaken by Mr. W. H. Johnson (Richard Johnson, Clapham & Morris, Limited), whose address is Lever Street, Manchester.

NEW COMPANIES.

TWO-STROKE ENGINE COMPANY, LIMITED.—Capital, £10,000.

YORKSHIRE AND WESTMORELAND COPPER COMPANY, LIMITED.—Capital, £1,000.

HARVEY & WOOD, LIMITED.—Capital £600, to carry on the business of iron, brass, and general founders, etc.

WM. MALCOLM & COMPANY, LIMITED.—Capital £5,000, to acquire the engineering business of Wm. Malcolm & Company, Whitla Street, Belfast.

W. BOYDELL & SONS, LIMITED.—Capital £7,000, to acquire the business carried on at Brown Street Iron Works, Leigh, Lancashire, by W. Boydell & Sons.

TEAGUE & CHEW, LIMITED.—Capital £7,000, to acquire the business carried on at the Heywood Engine Works, Cinderford, as Teague, Chew & Morman.

MIDDLESEX FOUNDRY AND METAL COMPANY, LIMITED.—Capital £2,000 in £1 shares, to adopt an agreement with P. Cohn. Registered office: Chesterfield House, 98, Great Tower Street, E.C.

E. CAMELINAT & COMPANY, LIMITED.—Capital £5,000, to take over the business of metal spinners and manufacturers carried on by E. G. Camelinat and W. Ward, at Legge Lane, Birmingham.

WILLIAM DUFF & COMPANY, LIMITED.—Capital £3,000, to acquire the business of manufacturing boiler coverers and engineers, carried on by Wm. Duff & Company, 60, Elliott Street, Cranstonhill, Glasgow.

RIPPINGILLE MANUFACTURING COMPANY, LIMITED.—Capital £2,000, to take over the business of a manufacturer of stoves, iron, steel, and brass castings, etc., carried on in Plume Street, Aston, by the Rippingille Manufacturing Company.

W. & T. OVENS, LIMITED.—Capital £3,000 in £1 shares, to acquire the business carried on at St. John Street, West Smithfield, E.C., as W. & T. Ovens, and to carry on the business of ironfounders, etc. Registered office: 54, St. John Street, Clerkenwell, E.C.

THE following limited partnership has been registered:—Geo. W. Green & Company, engineers, Crown Works, Guildford Street, Lambeth. Partnership for five years from March 12, 1908. General partner: G. W. Green, above address. Limited partner: A. C. Poole, 42, The Mall, Ealing.

PERSONAL.

THE late Lord Kelvin left personal estate of the value of £161,923 11s. 9d., and heritage £7,150.

THE gross value of the estate of the late Mr. T. Sproat, ironfounder, of Hebburn, is £6,127 16s. 6d.

MR. A. F. HILLS, chairman of the Thames Ironworks Company, Limited, has been somewhat seriously ill.

THE late Mr. J. Reeves, formerly manager with the Anderston Foundry Company, Limited, left estate to the value of £3,221 3s. 7d.

THE value of the personal estate of the late Mr. R. B. Smith, ironfounder, of Smith & Wellstood, Limited, has been returned at £89,835.

THE late Mr. I. Nash, of Messrs. Isaac Nash & Sons, of Stourbridge and Belbroughton, left estate of the gross value of £63,001 12s. 9d.

MR. LESTER G. FRENCH has been appointed to direct the editorial department of the American Society of Mechanical Engineers.

MR. L. N. WILLIAMS, managing director of E. Thomas & Williams, Limited, Aberdare, has been placed on the Commission of the Peace for the County of Glamorgan.

MESSRS. J. E. SOUTHERN and J. SHARP have been elected directors of the Lancashire Wagon Company, Limited, in the place of Messrs. J. Peacock and T. Bradbury, resigned.

MR. W. A. HARTLEY, the general manager of Cammell, Laird & Company, has severed his connection with the firm. He held the office for three years, and had been 10 years with the company.

MR. C. S. MARTIN, general manager of Messrs. Cammell, Laird & Company's Works in West Cumberland, has been elected a director of the Cleator and Workington Junction Railway Company.

MR. A. BOURNE, of Messrs. R. A. King & Company, engineers, Westminster, London, S.W., has joined the staff of Messrs. Cunningham & Morrison, Balfour House, Finsbury Pavement, London, E.C.

SIR HUGH BELL, BART., has been presented with an illuminated address by the members of the Tees Valley Water Board, in recognition of his services as chairman of the board during the past 31 years.

MR. A. SCOTT, secretary of Alex. Stephen & Sons, Limited, shipbuilders, Linthouse, and Mr. M. Hunter, shipyard manager, have been appointed directors of the company, and Mr. T. M'Ilmoil has been appointed secretary.

MR. L. BURROWS, manager of the steel foundry and shell departments at Messrs. Cammell, Laird & Company's Sheffield Works, has been the recipient of a presentation from the officials and men on the occasion of his retirement.

THE late Mr. A. Buchanan, for some time working manager for Swan, Hunter & Wigham-Richardson, Limited, and latterly identified with a large ship repair works and boiler shop at Barrow, left estate valued at £6,745 16s. 10d. gross.

MR. BARKER, assistant to Mr. W. A. Hartley, has been appointed general manager of the Cyclops Works of Cammell, Laird & Company, Limited, and Mr. John Little, the company's engineer, has been appointed general manager of the Grimesthorpe Works.

IN consequence of the absence abroad of Mr. J. S. Warner, Mr. E. C. MacKellar, of the Warner Engineering Company, Limited, has been elected managing director of the company. Mr. J. A. O'Brien, late manager of the Barnsley tramways, has been elected a director of the company.

THE late Dr. H. C. Sorby left personal estate, the gross value of which has been sworn at £45,643 15s. 1d. The chief public bequests are to the University of Sheffield, viz:—To endow a professorship of Geology, £10,000. To establish a Fellowship or Professorship for carrying on original scientific research, £15,000. (This bequest is directly to the Royal Society of London, to devote the income to the object named.) Books, scientific instruments, specimens, etc. He has also left valuable scientific articles, pictures, photographs, etc., to the city of Sheffield for the Weston Park Museum.

——o——

THE EXCELSIOR FOUNDRY COMPANY, Sandiacre, Nottingham, have appointed Mr. E. R. Persey, 74, Butler Road, Harrow, as their London representative.

MR. MORTON BEALES, lately with Bruce, Pebbles & Company, Limited, has joined Mr. M. M. Gillespie, and will in future trade as Gillespie & Beales, buying and selling engineers, etc., Amberley House, Norfolk Street, Strand, W.C.

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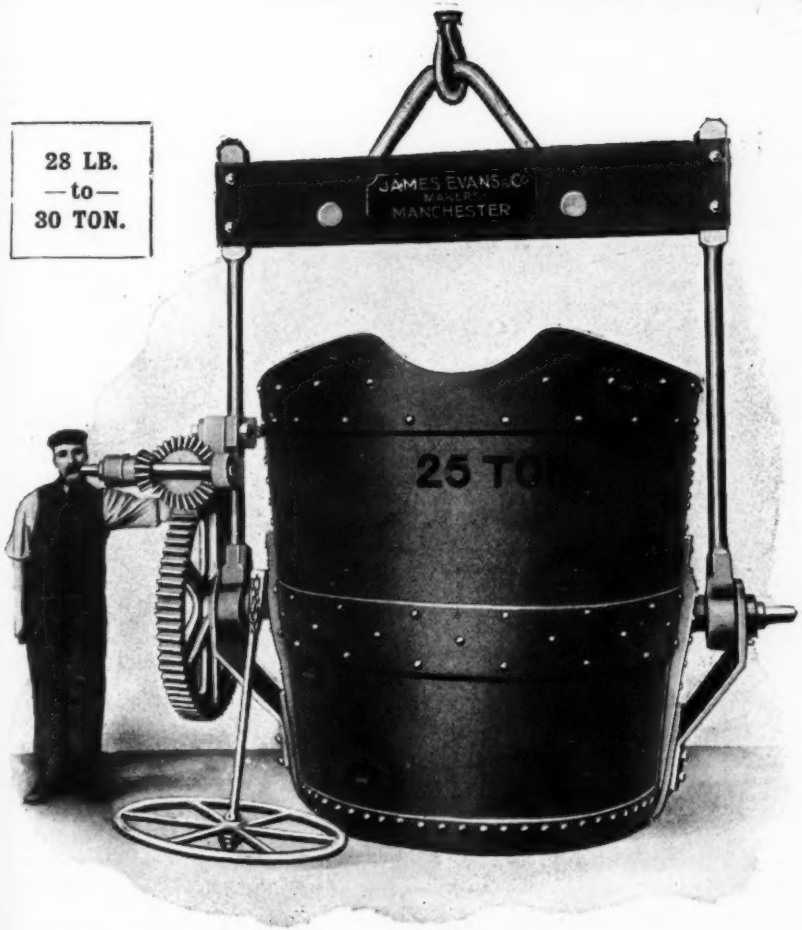

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OBITUARY.

MR. R. LEWIS, of Messrs. M'Ilwaine & Lewis, shipbuilders, of Belfast.

MR. G. WALKER, of the Station Foundry, Mansfield, aged 91 years.

MR. L. HAYWOOD, of the Phœnix Foundry Company, Derby, aged 78 years.

MR. T. SMITH, of R. Heath & Sons Limited, Black Bull Iron Works, Stoke-on-Trent.

MR. W. PRATCHITT, of Messrs. Pratchitt Brothers, engineers, Carlisle, in his 76th year.

MR. G. H. LORD, senior partner of Messrs. G. H. Lord & Son, engineers, Dundee, aged 67 years.

MR. G. RUSSELL, at one time general manager of the Summerlee Iron Works, Coatbridge, aged 76 years.

MR. A. PETTER, a director of John Lysaght, Limited, of Bristol and Newport, Mon., aged 68 years.

MR. J. HARDY, an engineer, who had represented Messrs. Marshall, of Gainsborough, at Calcutta for some years.

MR. H. T. SIMPSON, secretary to the Gloucester Railway Carriage and Wagon Company, Limited, at the age of 73 years.

MR. J. H. LEES-MILNE, J.P., chairman of Asa Lees & Company, Limited, Soho Iron Works, Huddersfield Road, Oldham.

MR. WILLIAM MILLINGTON, for some years superintendent of Lord Ellesmere's Worsley and Walkden depôts and workshops, aged 67 years.

MR. J. WIGHAM-RICHARDSON, vice-chairman of Swan, Hunter & Wigham-Richardson, Limited, shipbuilders and engineers, aged 71 years.

MR. M. H. LARMUTH, senior surviving partner in the firm of Messrs. T. Larmuth & Company, Todleben Iron Works, Salford, Manchester, aged 76 years.

MR. W. WILLIAMS, of Morriston, in his eighty-fourth year. For 40 years he was manager of Messrs. Vivian & Sons' Hafod Foundry, winning the esteem of both employers and workmen.

COL. HENRY F. SWAN, one of the managing directors of Sir W. G. Armstrong, Whitworth & Company, Limited, aged 66 years. He was also a director of the Wallsend Slipway and Engineering Company, Limited; the Weardale Steel, Coal, and Coke Company, Limited; and the Cargo Fleet Iron Company, Limited.

MR. THOMAS BARLOW-MASSICKS, who was connected in its early days with the Millom Hematite Iron Company, Limited, and afterwards with the Millom and Askam Hematite Iron Company, Limited, being managing director for 20 years. He was also connected with Claye's Wagon Works, at Barrow, with the late Mr. David Laird. He left the Millom Company some twelve years ago, and subsequently re-opened the Lonsdale Iron Works, at Whitehaven, since demolished.

COLONEL SIR CHARLES EDWARD HOWARD VINCENT, Member of Parliament since 1885 for the Central Division of Sheffield, aged 58. Educated at Westminster School and at the Royal Military College at Sandhurst, he served for a time in the army, but eventually took up the law, and was admitted a barrister of the Inner Temple in 1876. In 1878 he was appointed Director of the Criminal Investigation Department of the Metropolitan Police, and held the post for six years. With Sir Howard's retirement from Scotland Yard began his political career. In trade circles Sir Howard was well known, and though he was not a director of many companies, those he served on indicated a considerable variety of interests. Latterly he was associated with the boards of only three concerns—Hadfield's Steel Foundry, Limited, and two others.

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From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

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We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

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Elders Navigation Collieries, LTD. Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1907-8.	1906-7.
Iron—Scotch pig warrants ... ton	*56 0	*65,9
—Middlesbro' warrants ... ... ton	51/6	59,7
—W.C. M/nos Bessemer ... ... ton	62,0	79 6
—Stock, Scotch, April 30 ... tons	1,000	3,912
Copper—Chili bars, GMB ... ... ton	£57 10 0	£107 5 0
—Stock, Europe & afloat... ... tons	23,702	12,958
Tin—English ingots ton	£141 10,0	£199 0,0
—Straits ... ton	£143 0 0	£196 0,0
—Stock, Ldn. Hlnd and afloat ... tons	13,262	10,111
Lead—English pig ton	£13 12 6	£20 13 9
Spelter—Ord. Silesian ... ... ton	£21 2,6	£26 0,0
Quicksilver-(75lb.) bottle	£8 4,6	£6 16,0-£7 0,0
Antimony—Regulus ... ... ton	£33 10 0	£88 0,0-£92 0 0

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 2 6	to	5 7 6
,, 3 to 4 in.	4 15 0	to	5 5 0
,, 5 to 8 in.	4 12 6	to	4 15 0
,, 10 to 16 in.	4 12 6	to	4 15 0
,, 18 to 24 in.... ...	4 12 6	to	4 15 0
Chairs	3 10 0	to	3 15 0
Floor plates (open sand)	3 2 6	to	3 5 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 7s. 0d.; light wrought, £1 1s. 0d.; heavy cast, £2 6s. 0d.; all per ton f.o.b., London. Copper (clean), £54 0s. 0d.; brass (clean), £42 0s. 0d.; lead (usual draft), £12 5s. 0d.; tea lead, £10 10s. 0d.; zinc, £16 10s. 0d.; all per ton delivered merchant's yard.

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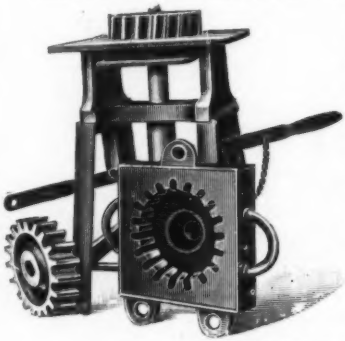

The advantages of these Machines over the ordinary methods of Moulding are so great that no foundry which has any call for repetition work should be without them. The saving in labour alone in many cases reaches as much as 75 per cent., and the castings are much more accurate, being exact duplicate of each other, and with scarcely any fin at the joint. No skilled labour is required, it is simply necessary to shovel in the sand and ram it, lower the lever and remove the Moulding Box. There is no rapping of the Pattern required, no patching nor sponging, and the time occupied is but a fraction of that required in the ordinary manner of moulding.

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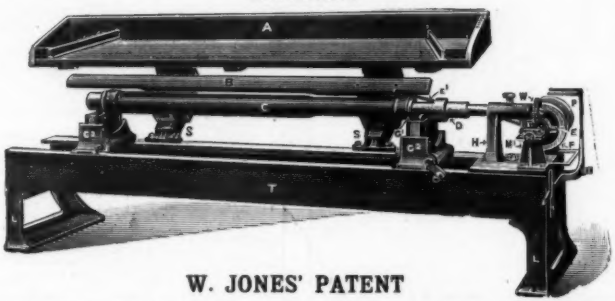

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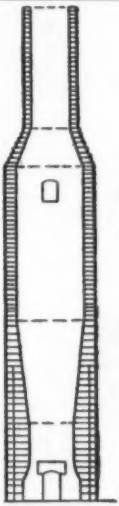

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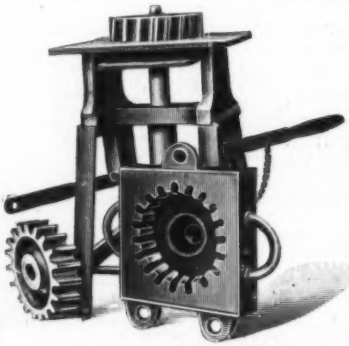

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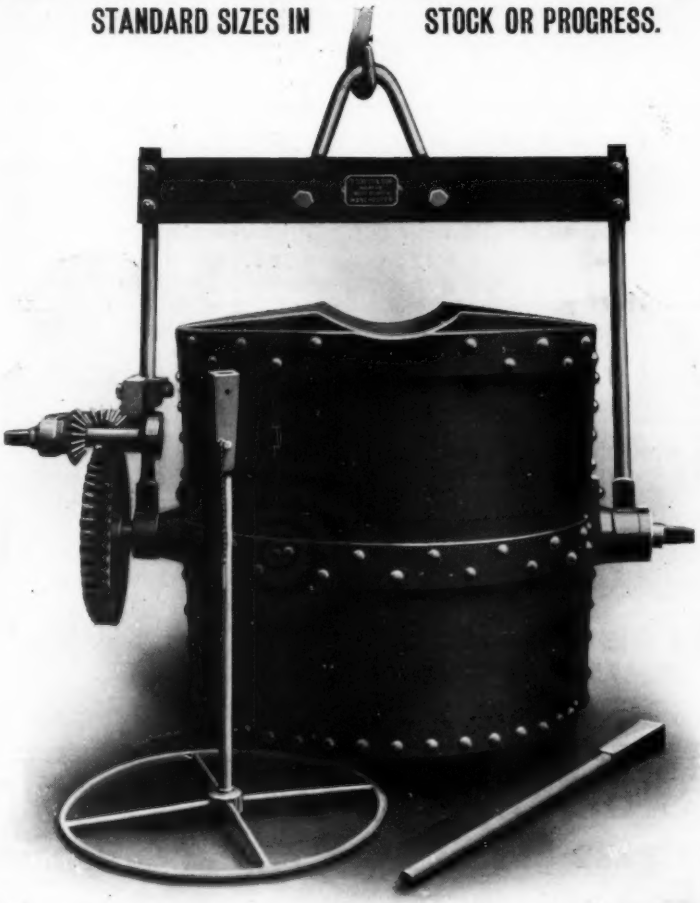

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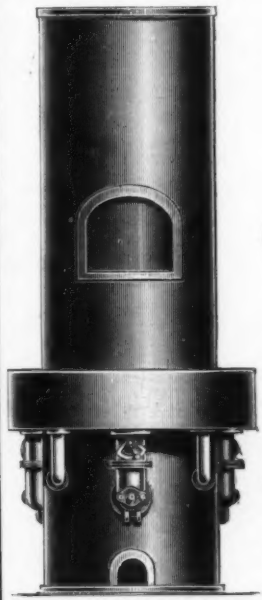

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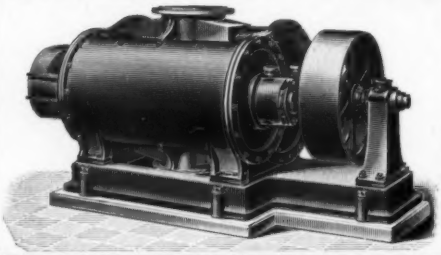

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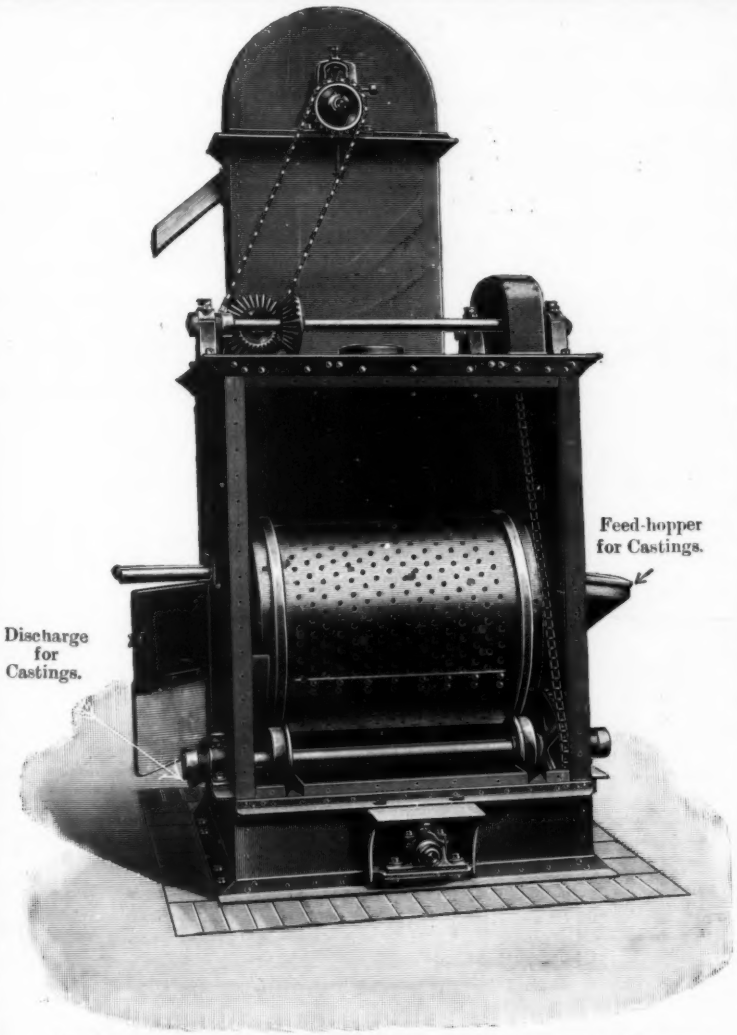

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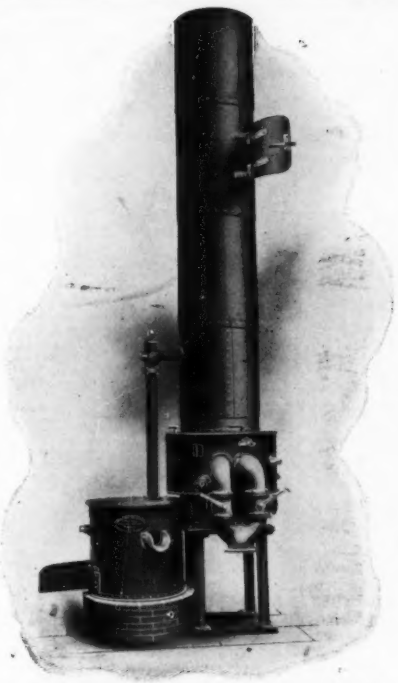

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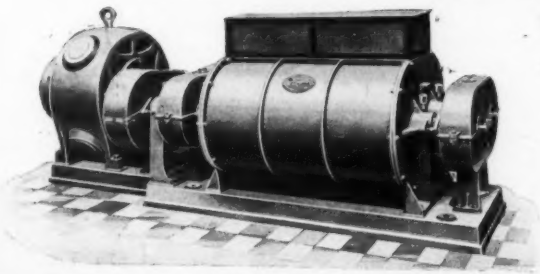

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